

NATIONAL RECONNAISSANCE OFFICE

Schedule Execution Metrics

*The value proposition for adding Baseline Realism,
Baseline Progress and Forecast Realism to the
Scheduler Analyst's Toolkit*

June 2017



SUPRA ET ULTRA



Abstract

In response to National Reconnaissance Office (NRO) Senior Management's need for metrics that are leading indicators of program execution challenges, the NRO Cost and Acquisition Assessment Group (CAAG) Earned Value Management Center of Excellence (ECE) developed a suite of Schedule Execution Metrics. The metrics are now part of the NRO Corporate tool box for senior leadership decision support. The metrics are derived from the Contractor's integrated master schedule to answer the questions:

- Is the contractor executing to the baseline plan?
- Is the contractor ahead or behind in completing the planned activities?
- Is the forecast realistic?

This briefing will define schedule execution metrics, explain how they are being used at NRO, and describe ongoing research tasks to establish thresholds and interpret the metrics.



Business Case for Schedule Execution Metrics at NRO

- What led to the creation of Schedule Execution Metrics (SEM)
 - We were tasked to create leading indicators to explain the true status of a program beyond the “green” conditions of program level CPI and SPI, and to provide an early indicator of a potential rebaseline
 - We were asked to provide clean, simple, easy-to-understand metrics
 - Many detailed cost and technical metrics already exist are reviewed extensively. We chose to emphasize schedule execution and schedule performance to fill a void.
 - JSCC Better EVMS Implementation Study II: Improving Value for Government PMs: Government PMs highly value the Integrated Master Schedule, and refer to it as managing “heads and scheds”
 - We rebranded existing NAVAIR, NRO internal and other metrics and created new metrics to fully analyze schedule performance.
 - Baseline Realism, work-off analysis (phasing of recovery), and other schedule execution metrics are used extensively across NRO programs offices. We standardized terminology and created automated tools to put Schedule Execution Metrics in the Corporate Toolbox
 - Measuring accomplishment against the contractor’s forecast is a fall back if there is a problem with the baseline plan
- Benefits of employing Schedule Execution Metrics at NRO
 - Excellent Insight on an Agile Program: The delta between baseline realism and baseline execution provided insight into the magnitude of reprioritization work. The metrics indicated the contractor was efficiently delivering software functionality, but highlighted the impact of Government's reprioritization through agile software management, and alerted the customer of potential work in the backlog that might not be completed
 - Better Insight Drives accountability When included in a suite of cost, schedule and technical metrics, schedule execution metrics isolated underlying schedule issues leading to corrective action targeted to keep the program on schedule including: assigning dedicated effectivity and test campaign leads, investing in the improvement of testing environments, more complete detail planning when ECP work is added to the contract.



How Schedule Execution Metrics can help Industry

The suite of Schedule Execution Metrics tells a more complete story

- Provides feedback to the planning process
 - Is the work really being performed as it was planned? How much can the plan deviate and still be useful as a plan (use of float, margin)?
- Identifies upcoming planning challenges
 - Are future activities in jeopardy of finishing late? Is there a bow wave of activities on the horizon?
- Highlights issues that are not necessarily identified by technical metrics
 - How much effort is regularly being spent on activities that are already more than 30d late?
- Supplements typical schedule presentation
 - Is accomplishment of tasks supporting the standard Gantt Chart view? Is there a potential impact to the critical path?



Challenges in Typical Schedule Reporting

Typically EVM Metrics provided to Senior Leadership

	SV	CV	VAC
Program Level	↑	↑	↔
BUS	↑	↑	↑
PAYLOAD	↑	↑	↑

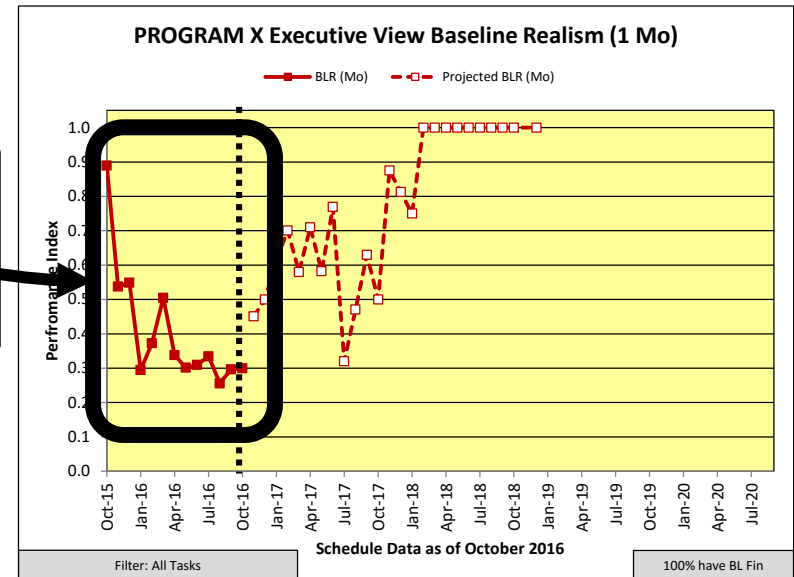
Notional Data

EVM
VS
SEM

Program-level Cumulative *Schedule Variance* can look favorable, even if there are execution challenges:

- Historic performance can heavily weight the indicator to “green”

Schedule Execution Metrics can provide Additional Insight



Notional Data

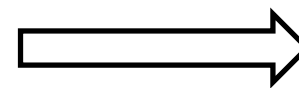
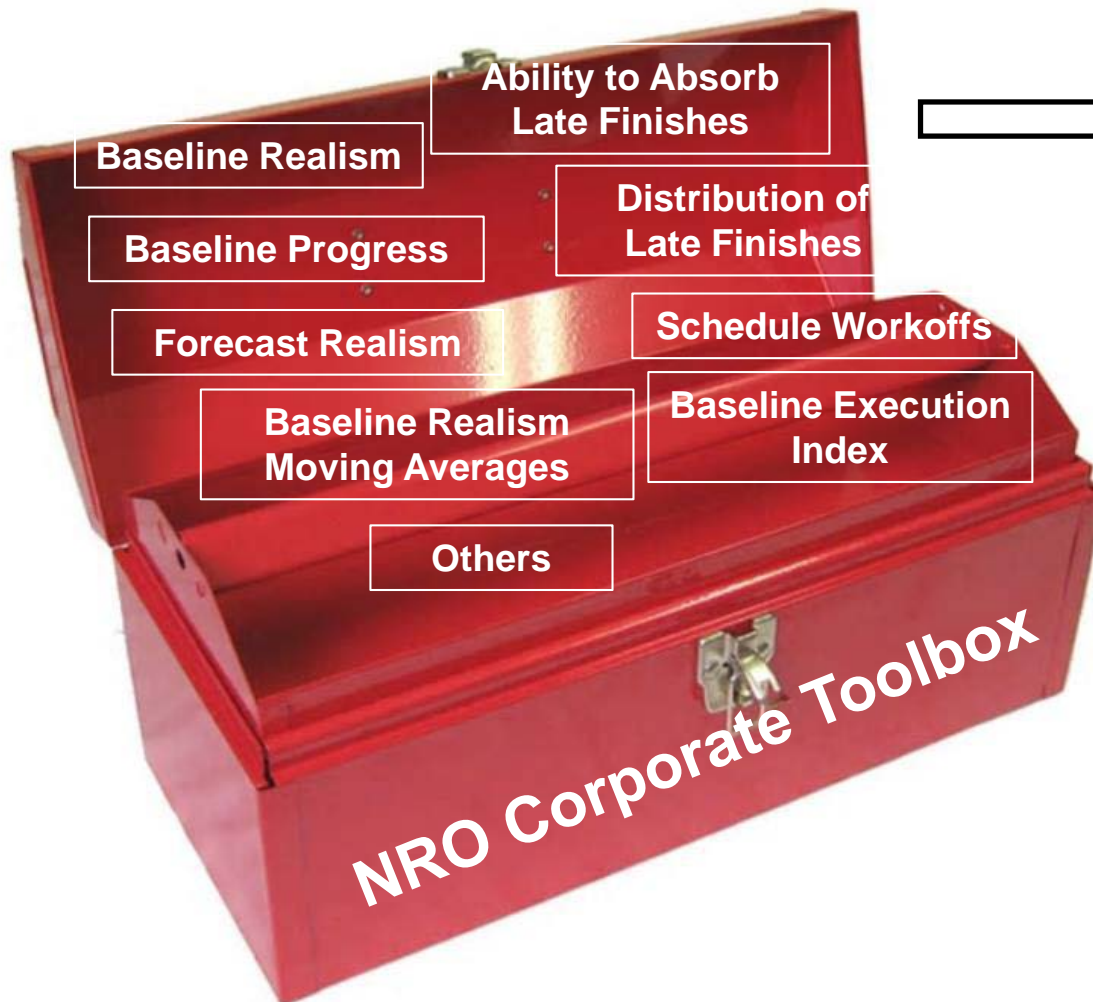
Baseline Realism can provide an early indicator that a contractor is not performing the work as planned

Senior Leaders ask for leading indicators of execution challenges

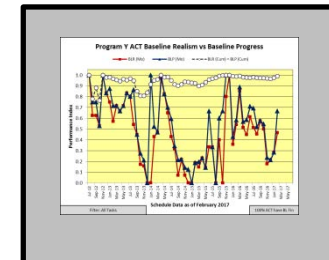


Schedule Execution Metrics as part of the NRO Corporate Toolbox

Schedule data and analysis is part of the EVM data set



Baseline Realism is one of many metrics that can be used to assess schedule performance





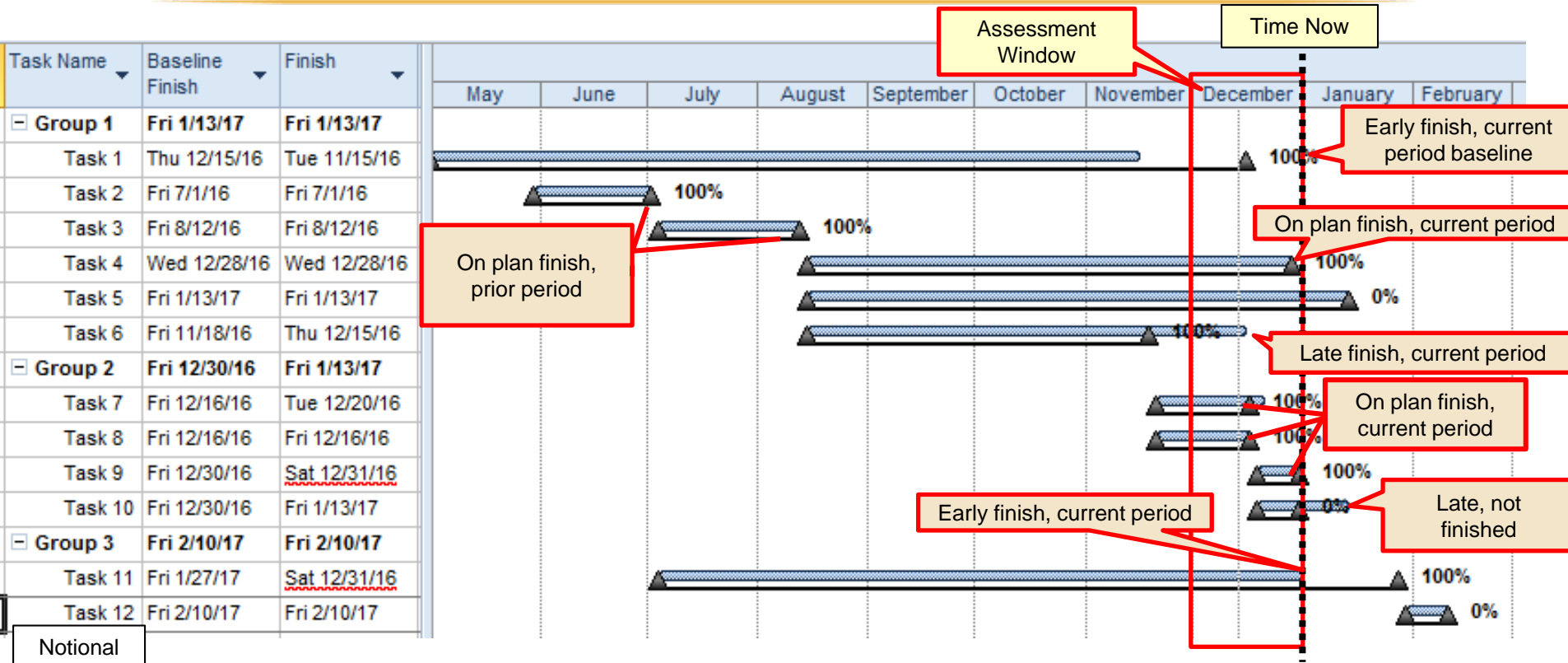
We recommend a combination of new and existing Schedule Execution Metrics to answer 3 critical questions

Question	Metric/Analysis	What it Means
Is the contractor executing the baseline plan?	Baseline Progress	<i>Prior to “time now” Activities completed early or on time / baseline activities planned finishes over a specified period of time</i> <i>After “time now” Activities forecasted early or on time / baseline activities planned finishes over a specified period of time</i>
	Baseline Realism	<i>Prior to “time now” Assessment of the completions of specific baseline plan finishes over a specified period of time</i> <i>After “time now” Assessment of the forecasted completions of specific baseline plan finishes over a specified period of time</i>
Is the contractor ahead or behind?	Critical Path Verification	<i>Identification of Critical Path activities to any specific deliverable or milestone</i>
	Critical Path Length Index	<i>(Duration to a specific deliverable or milestone + float and margin) / duration to a specific deliverable or milestone</i>
	Schedule Margin Remaining	<i>Schedule margin as percentage of remaining time to a deliverable or milestone</i>
Is the forecast realistic?	Forecast Realism	<i>Prior to “time now” Number of tasks actually completed / number of tasks forecasted to finish in a previous IMS version of the IMS</i> <i>After “time now” Number of tasks forecasted to complete / number of tasks forecasted to finish in a previous IMS version of the IMS</i>
	Schedule Workoff	<i>Prior to “time now” Percentage of activities completed each month that are more than 30 days late</i> <i>After “time now” Percentage of activities in the future that are forecasted to be more than 30 days late</i>
	Total Float Consumption Index	<i>(Actual Duration + Critical Path Total Float) / Actual Duration</i>

Note: One or more specified period of time can be one to six months, or a cumulative value



Illustration - December 2016 Status



Legend

Baseline Start

Progress (ending at forecast or actual finish)

Baseline Finish

100%

Percent Complete

Early

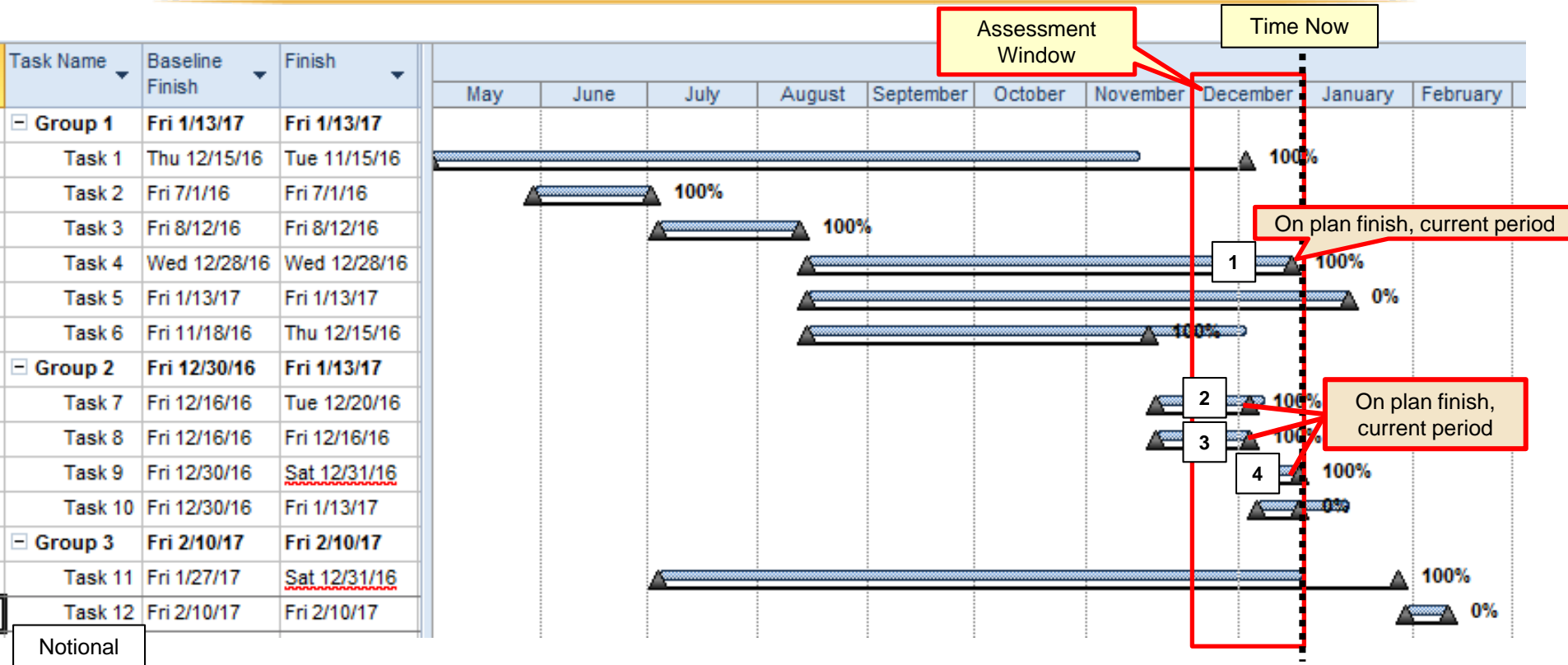
100%

Late

100%

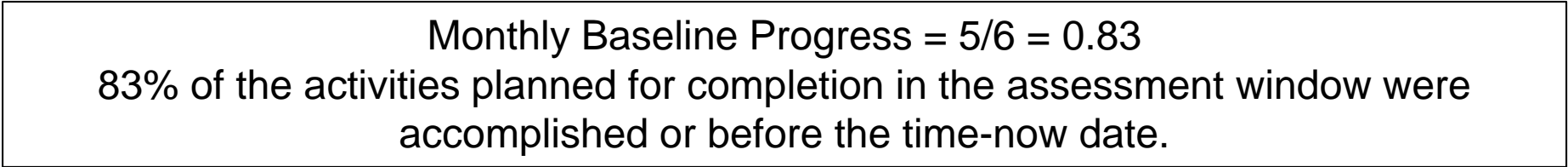


Illustration – Baseline Realism: On Plan Finishes for Activities with Baseline Finishes within the assessment window



Monthly Baseline Realism = $4/6 = 0.66$
 66% of the of the activities planned for completion in the assessment window were completed *during* the assessment window.

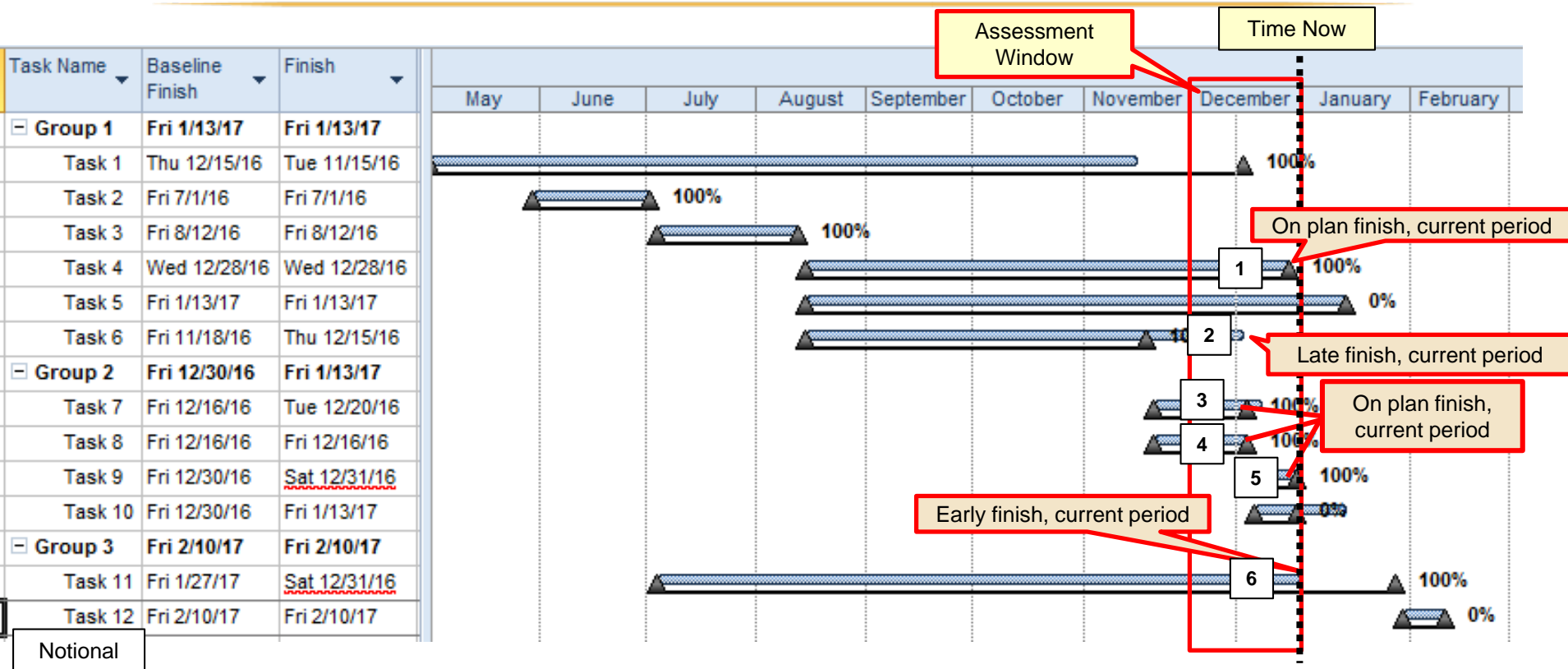
Note : Cumulative Baseline Execution = $8/9 = 0.89$



BPO/CAAG/ECE



Illustration – Baseline Execution: All On Plan, Early, & Late Finishes within the assessment window



Monthly Baseline Execution = $6/6 = 1.00$

The pace of work is 100% of what it was planned to be during the assessment window, although the completed activities were not necessarily the ones that were planned for completion.

Note : Cumulative Baseline Execution = $9/9 = 1.00$



Automated Tools versus Manual Analysis

			Automated Tool in Use	Future Automated Tool	Manual Analysis
Question	Metric/Analysis	What it Means			
Is the contractor executing the baseline plan?	Baseline Progress	<i>Prior to "time now" Activities completed early or on time / baseline activities planned finishes over a specified period of time</i> <i>After "time now" Activities forecasted early or on time / baseline activities planned finishes over a specified period of time</i>	✓		
	Baseline Realism	<i>Prior to "time now" Assessment of the completions of specific baseline plan finishes over a specified period of time</i> <i>After "time now" Assessment of the forecasted completions of specific baseline plan finishes over a specified period of time</i>	✓		
Is the contractor ahead or behind?	Critical Path Verification	Identification of Critical Path activities to any specific deliverable or milestone		✓	✓
	Critical Path Length Index	(Duration to a specific deliverable or milestone + float and margin) / duration to a specific deliverable or milestone			✓
	Schedule Margin Remaining	Schedule margin as percentage of remaining time to a deliverable or milestone	✓		
Is the forecast realistic?	Forecast Realism	<i>Prior to "time now" Number of tasks actually completed / number of tasks forecasted to finish in a previous IMS version of the IMS</i> <i>After "time now" Number of tasks forecasted to complete / number of tasks forecasted to finish in a previous IMS version of the IMS</i>	✓		
	Schedule Workoff	<i>Prior to "time now" Percentage of activities completed each month that are more than 30 days late</i> <i>After "time now" Percentage of activities in the future that are forecasted to be more than 30 days late</i>	✓		
	Total Float Consumption Index	(Actual Duration + Critical Path Total Float) / Actual Duration		✓	

Note: Data for Schedule Margin Metric can be Collected in Forecast Realism Tool



New Schedule Execution Metrics and how they compare widely available Baseline Execution Index (BEI)

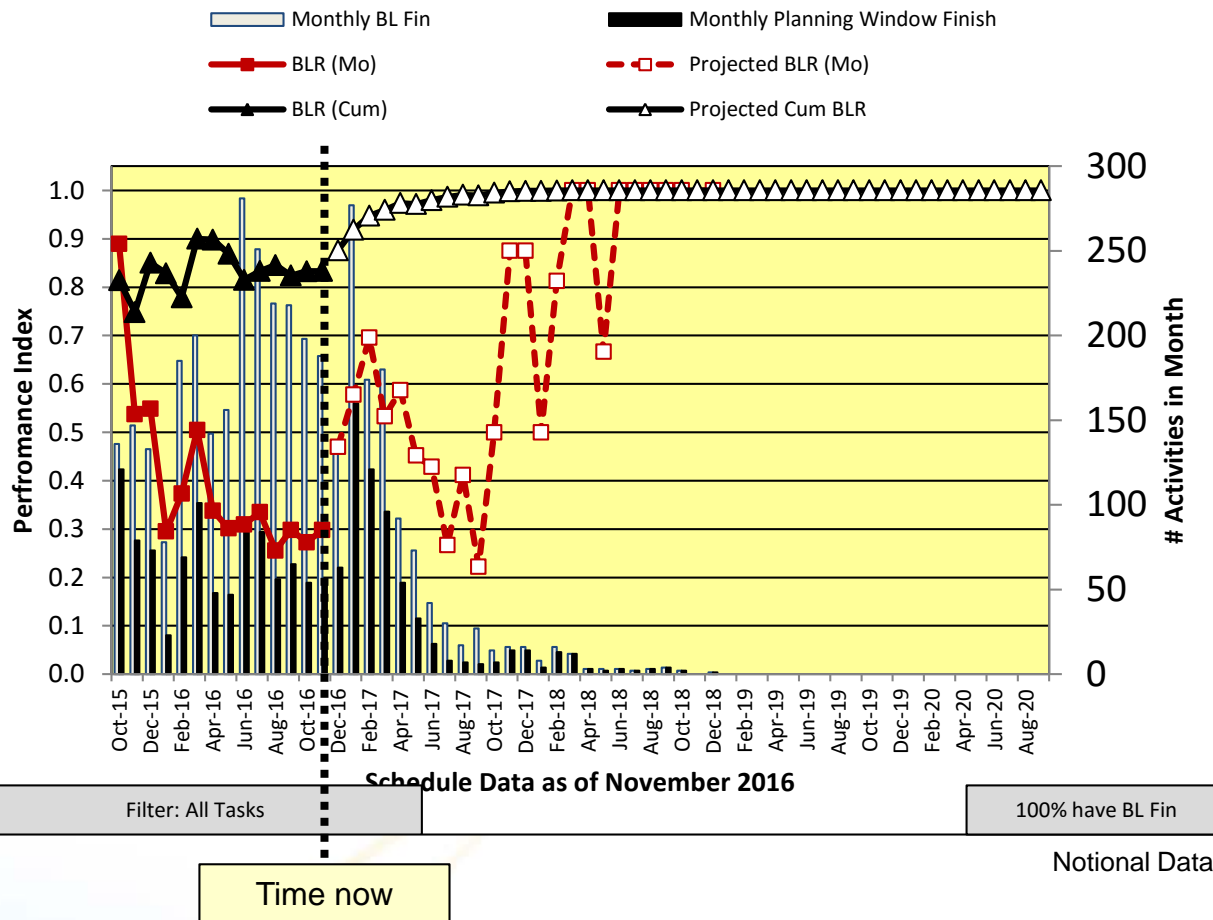
Metric	What it Tells You
Baseline Realism (BR)*	<p>Is the baseline being accomplished the way it was planned (by specific period or cumulative to date)?</p> <p>How well the contractor can do the work in the manner identified in the Integrated Master Schedule?</p> <p><i>Low BR can be a potential early indicator of need to replan</i></p>
Baseline Progress (BP)*	<p>What is the progress to “time now” against the plan (by specific period or cumulative to date)?</p> <p>Differs from BR in that it includes prior finishes if the task was baselined within the assessment window. Does not count early finishes for activities baselined to finish after the assessment window..</p> <p><i>Most PMs will be most concerned with Cumulative BP and Critical Path management</i></p>
Forecast Realism (FR)	<p><i>Are forecasted tasks being accomplished as forecasted?</i></p> <p><i>Provides insight into contractor's ability to complete the activities forecasted for completion in previous IMS submissions</i></p>
Baseline Execution Index (BEI)	<p>Execution Pace - Significantly different from BR and BP in that BEI does not look at the order or the plan</p> <p><i>BEI provides the actual pace of activities accomplished compared to the pace that was planned</i></p> <p><i>“BEI is the SPI of Schedule Execution Metrics” (BEI is based on activity finishes not dollars). Like SPI, BEI may not necessarily be a leading indicator. Unlike SPI, BEI does not give credit for partial completion</i></p>

Note: Cumulative BR is equal to Cumulative BP



Interpreting Baseline Realism

(Nov 2016) Activity Baseline Realism (Cum/Cur)



Light Blue Bars represent the count of activity baseline finishes *Prior to Time Now* - Black Bars represent actual activity finishes *After time now* - Black Bars represent forecasted activity finishes

Solid Red Line represents the percent of activity completions in the period they were baselined for completion

Dotted Red Line represents percent of activity completions forecasted to complete in the period they are baselined to be completed

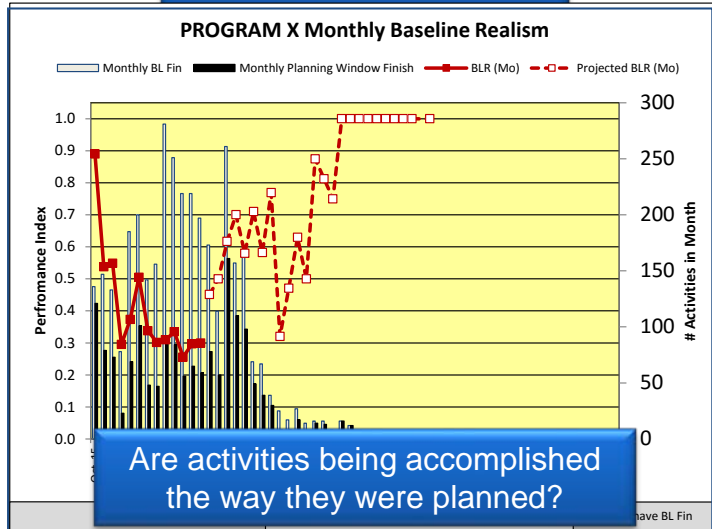
Solid Black Triangles represent Cumulative Baseline Realism (percent)

White Triangles represent Forecasted Cumulative Baseline Realism (percent)

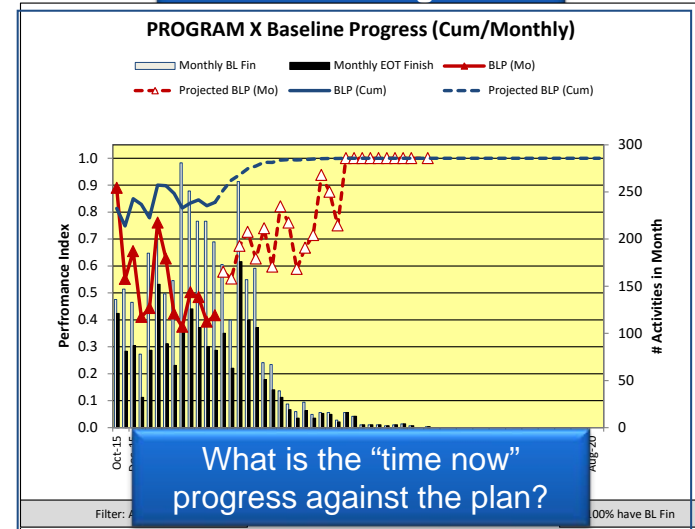


Screen shots of Schedule Execution Metrics (1)

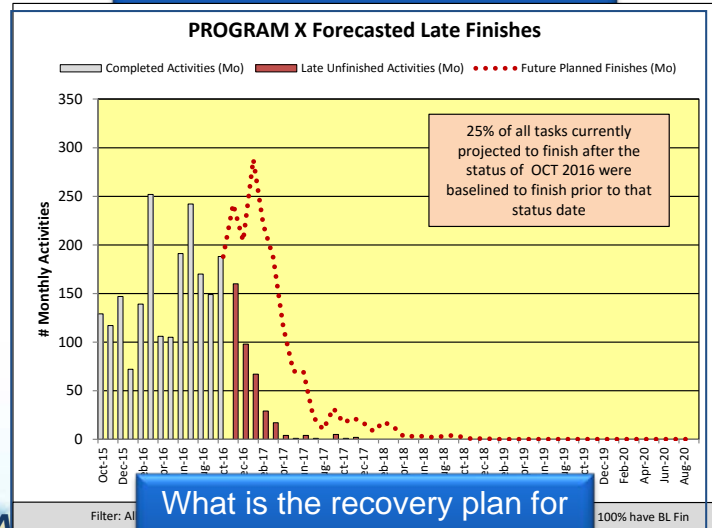
Baseline Realism



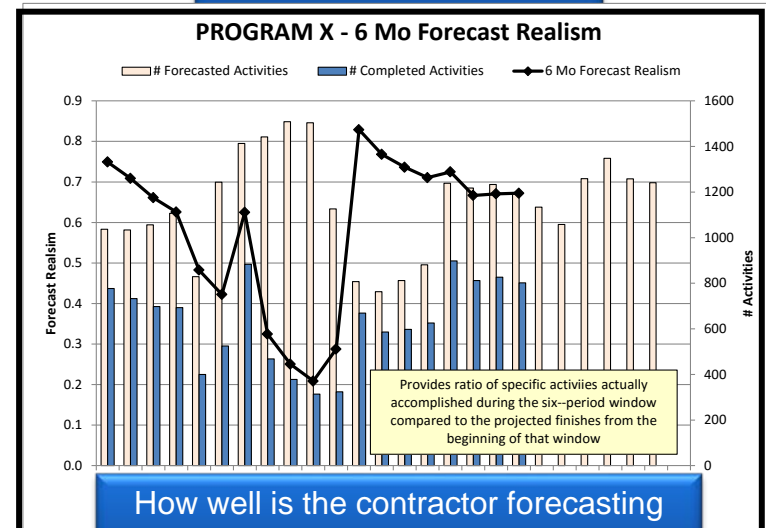
Baseline Progress



Forecasted Late Finishes



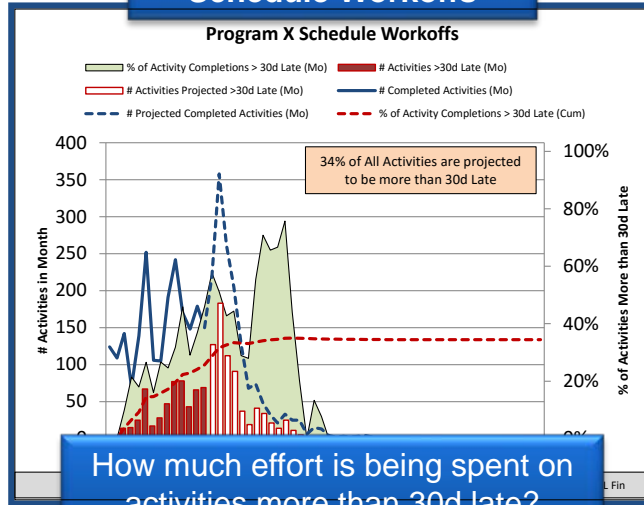
Forecast Realism



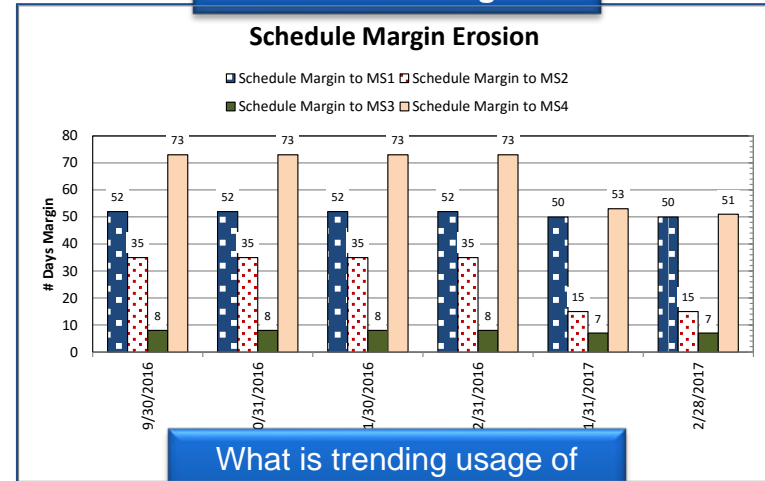


Screen Shots of Schedule Execution Metrics (2)

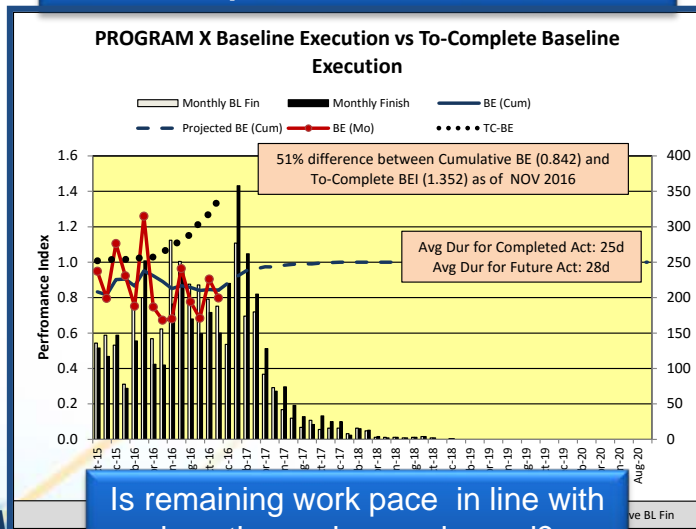
Schedule Workoffs



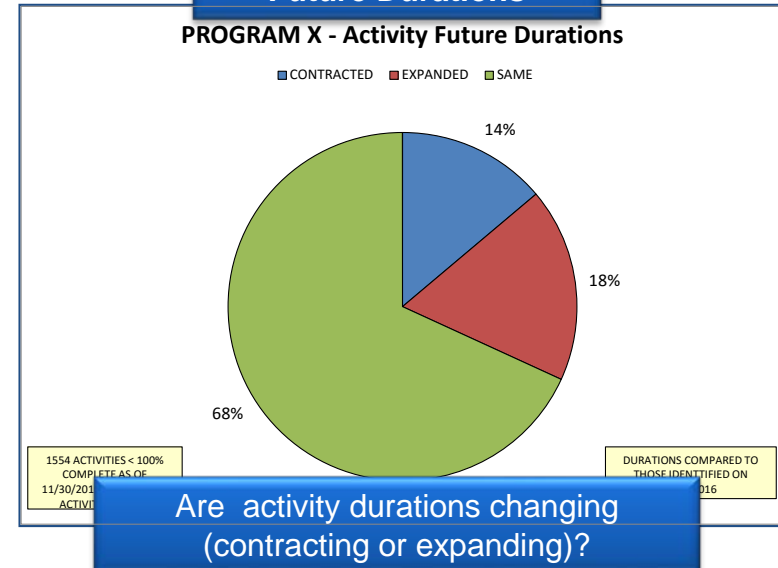
Schedule Margin



To-Complete Baseline Execution



Future Durations





ECE Schedule Execution Metric Capabilities

- Schedule Execution Metric methods are documented and have been presented over the last 6 months at NRO Scheduler's Forum
 - Terminology has been Branded
 - Formulas have been vetted
 - Charts have been presented to senior management
- NRO Earned Value Center of Excellence (ECE) has developed tools automated calculation
- ECE is currently working to benchmark Schedule Execution Metrics to better interpret results with respect to historical experience
- ECE is encouraging COTS vendors to consider incorporating Schedule Execution Metrics into IMS and IPMR Analysis Tools



Ongoing Research to Interpret Metrics

- What level or trend in Baseline Realism is an early indicator of an OTB?
- Can Baseline Progress values less than a certain value be regularly associated with an overrun or use of schedule margin?
- What is an expected benchmark for Forecast Realism?

Factors to Consider

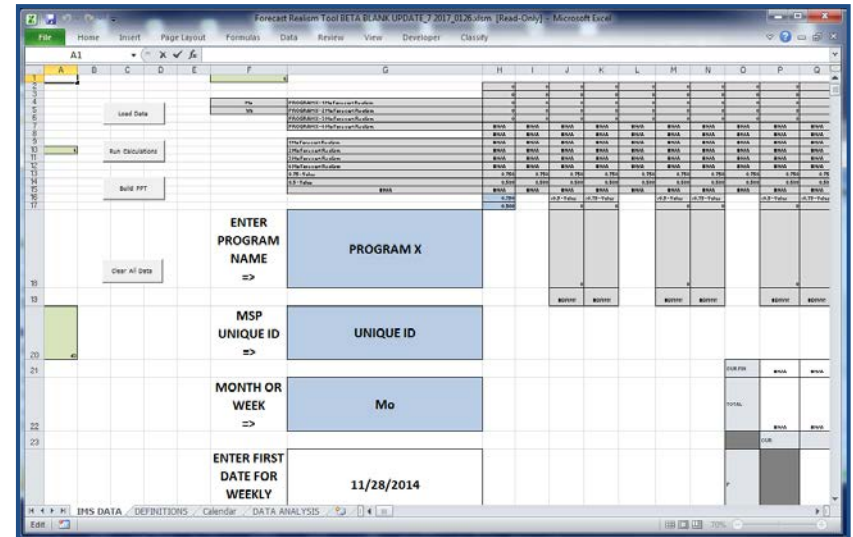
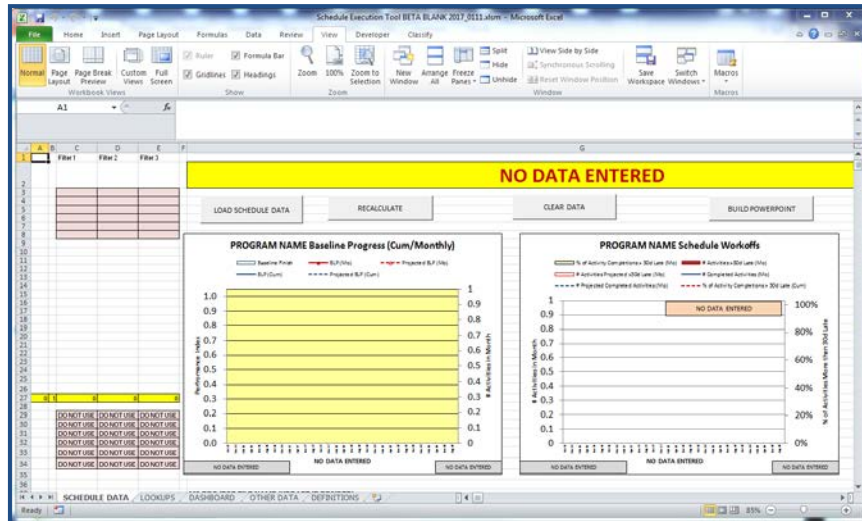
- Space Hardware versus Ground Software (in the Space and Ground community)
- Use of Schedule Margin, Management Reserve
- Follow-on effort versus New Development



Back-up



NRO Uses an Automated Tool to Calculate Schedule Execution Metrics



- Automated Data Entry and Chart Package Generation
- Microsoft Project Schedule, Microsoft Excel and Visual Basic
- Tool Outputs shown on following slides



PROGRAM XYZ - Schedule Finish Data Cumulative to Date

Based on historical data (before or equal to Status Date) AND selected MS Project Filter

Days Late/Early	# Activities	% of Total		
<-60	0	0%	2%	
<-30	9	2%		
>= -30 and <30	230	63%	63%	
>30	6	2%	2%	2%
>60	3	1%		
>90	0	0%	0%	
>120	0	0%		
>150	0	0%		
>180	0	0%		
NO BASELINE	116	32%	32%	32%

Notional Data



PROGRAM XYZ - Schedule Finish Data Future Activities

Based on future data (after
Status Date) AND selected MS
Project Filter

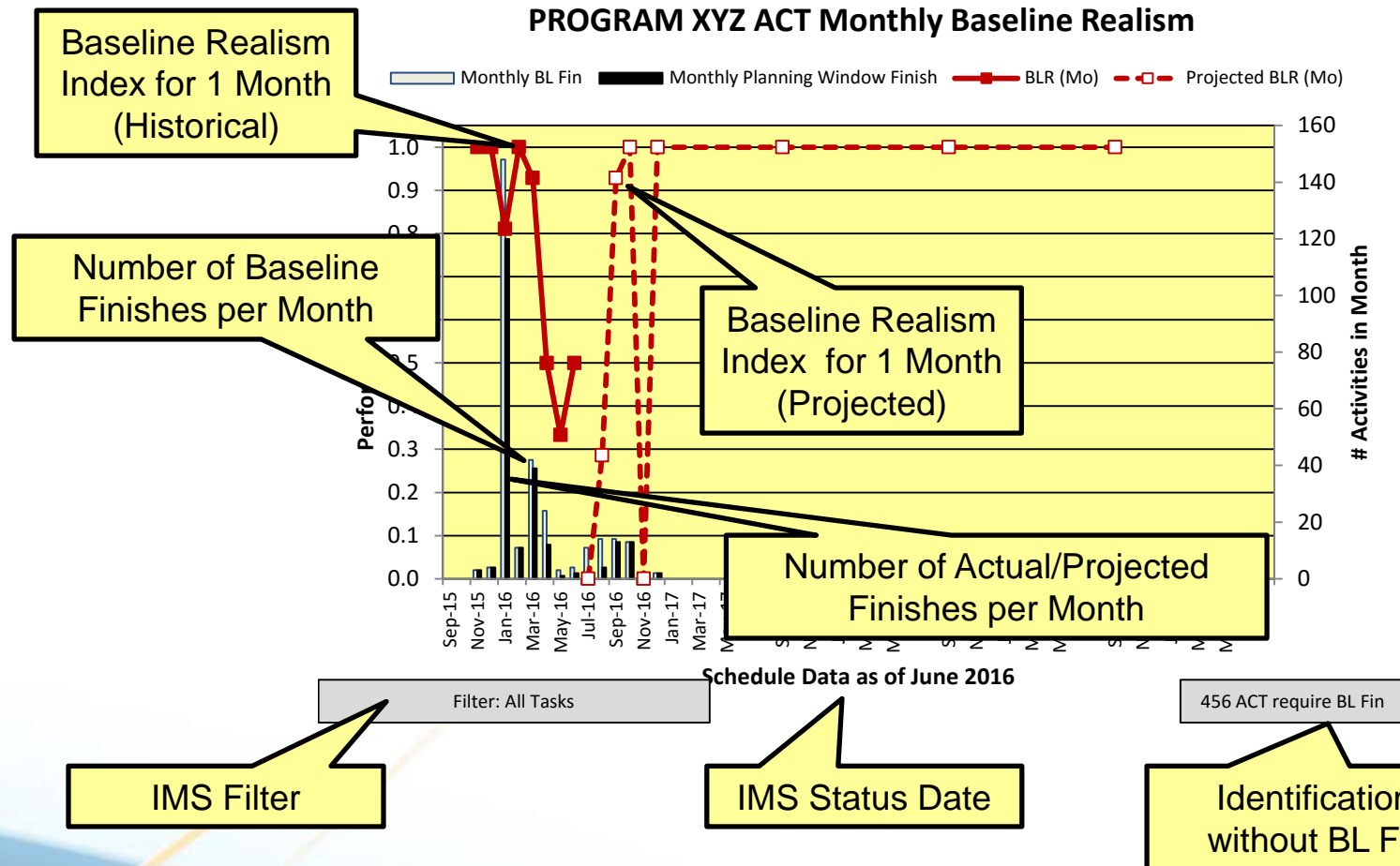
Days Late/Early	# Activities	% of Total		
<-60	0	0%	0%	
<-30	1	0%		
>= -30 and <30	41	11%	11%	
>30	2	1%	1%	2%
>60	1	0%		
>90	4	1%	1%	
>120	1	0%		
>150	0	0%		
>180	0	0%		
NO BASELINE	340	87%	87%	87%

Notional Data

Charts 3-5 provide an easy way
to see if the future trends are
significantly different than
historical data



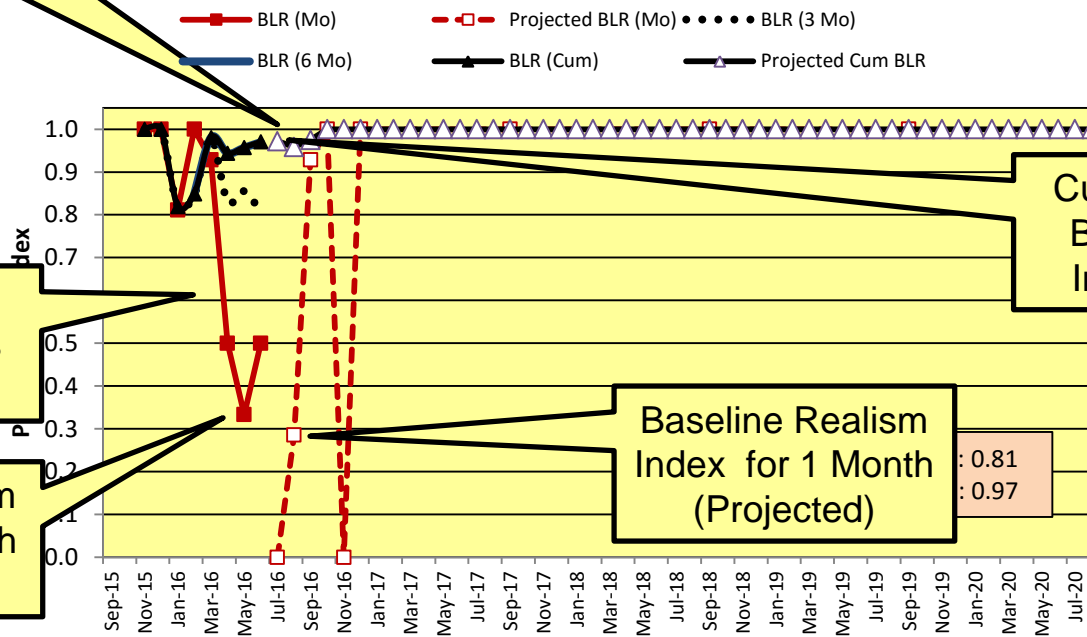
PROGRAM XYZ - ACT Monthly Baseline Realism





PROGRAM XYZ - ACT Multi-View Baseline Realism

PROGRAM XYZ Activity Multi-View Baseline Realism



Cumulative-to-Date
Baseline Realism
Index (Historical)

Baseline Realism
Index for 6 Months
(Historical) – *Not
Visible – Requires 6
months of data*

Baseline Realism
Index for 3 Months
(Historical)

Baseline Realism
Index for 1 Month
(Historical)

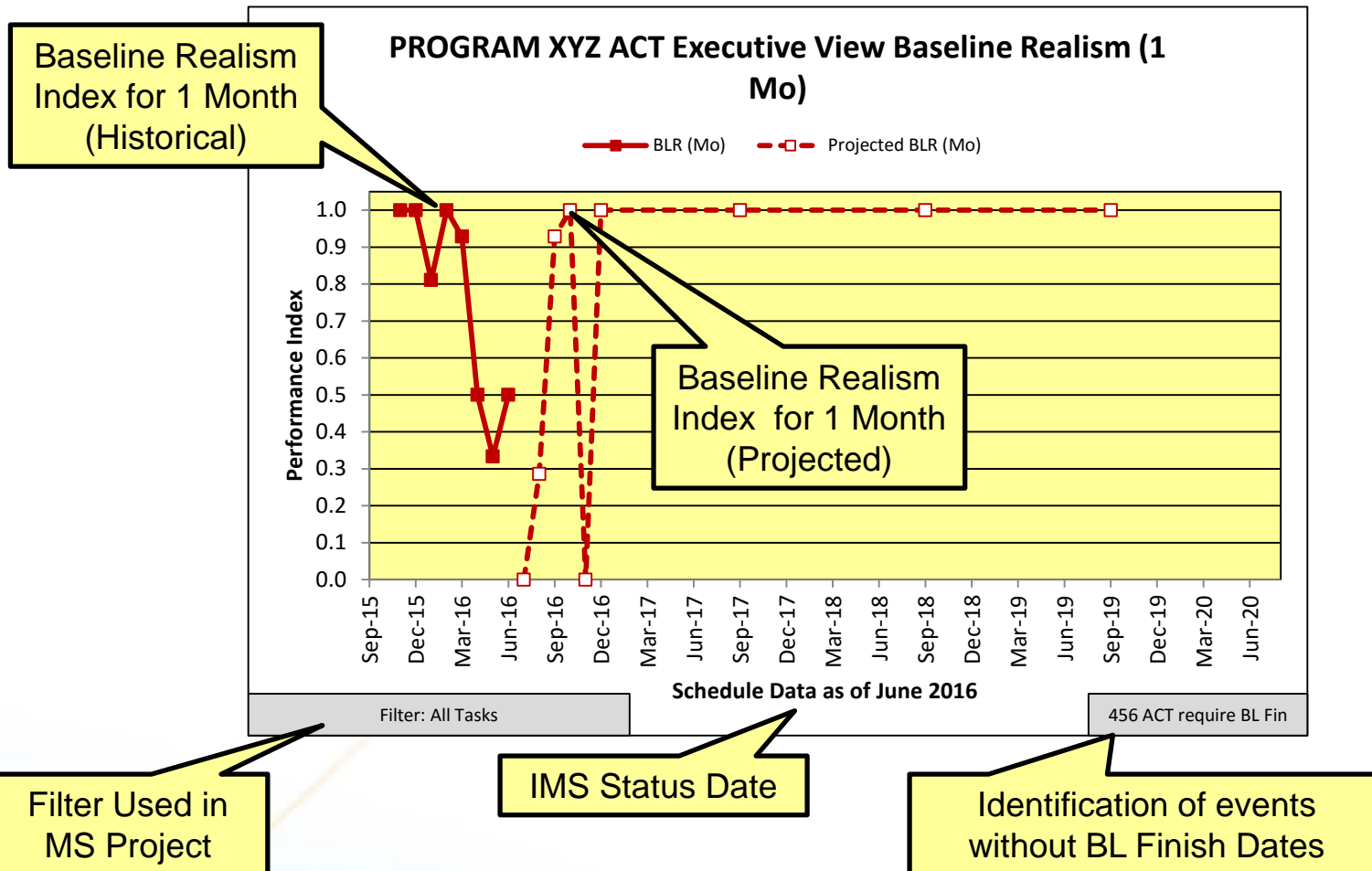
Filter Used in
MS Project

IMS Status Date

Identification of events
without BL Finish Dates

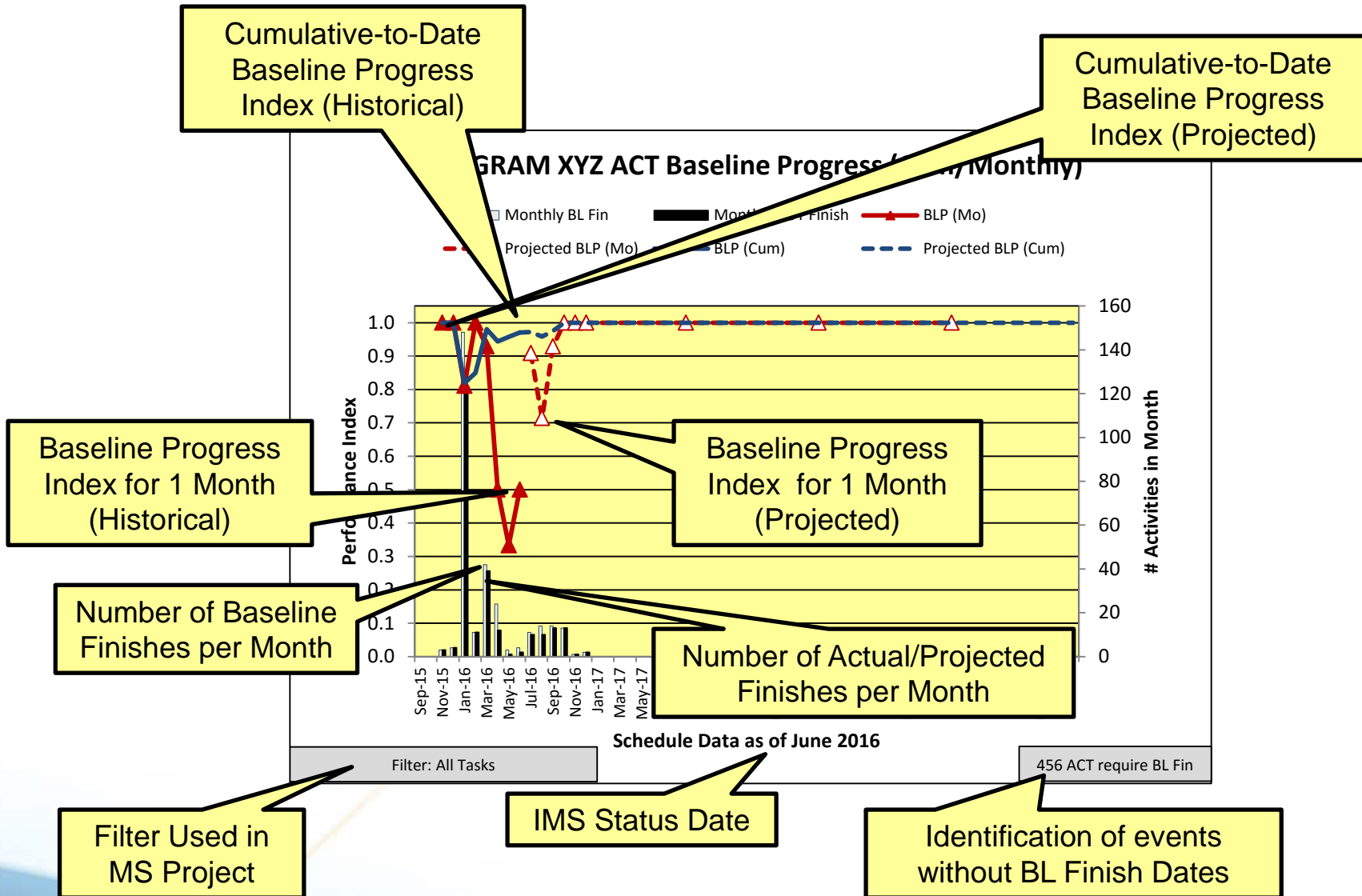


PROGRAM XYZ - ACT Executive View Baseline Realism



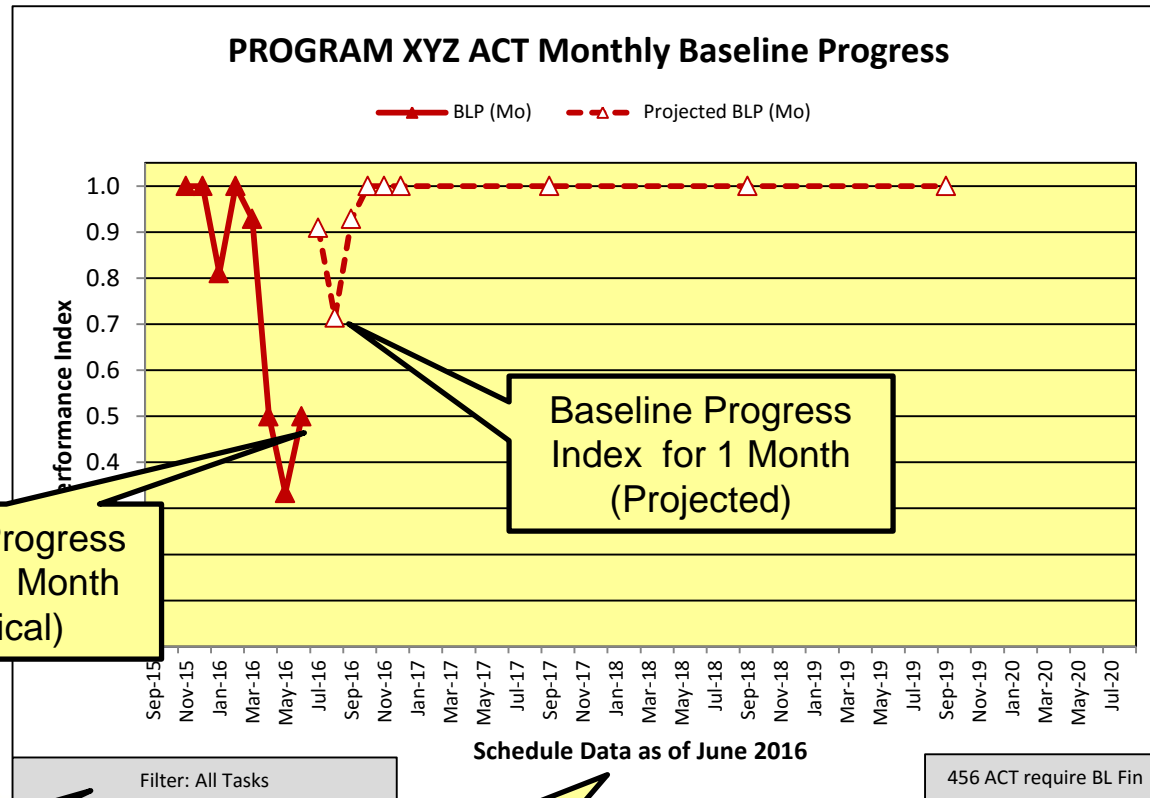


PROGRAM XYZ - ACT Baseline Progress (Cum/Monthly)





PROGRAM XYZ - ACT Monthly Baseline Progress



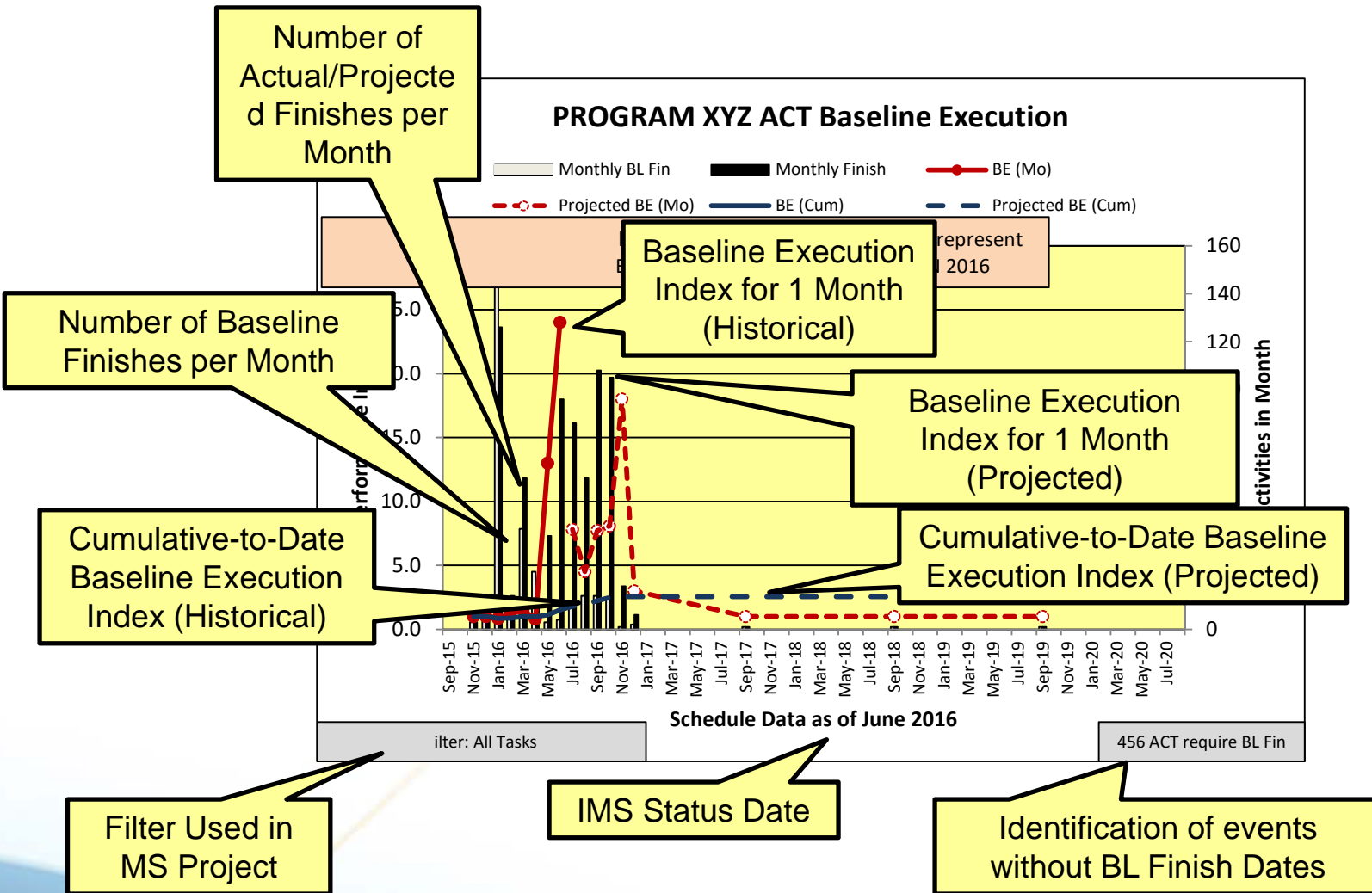
Filter Used in
MS Project

IMS Status Date

Identification of events
without BL Finish Dates

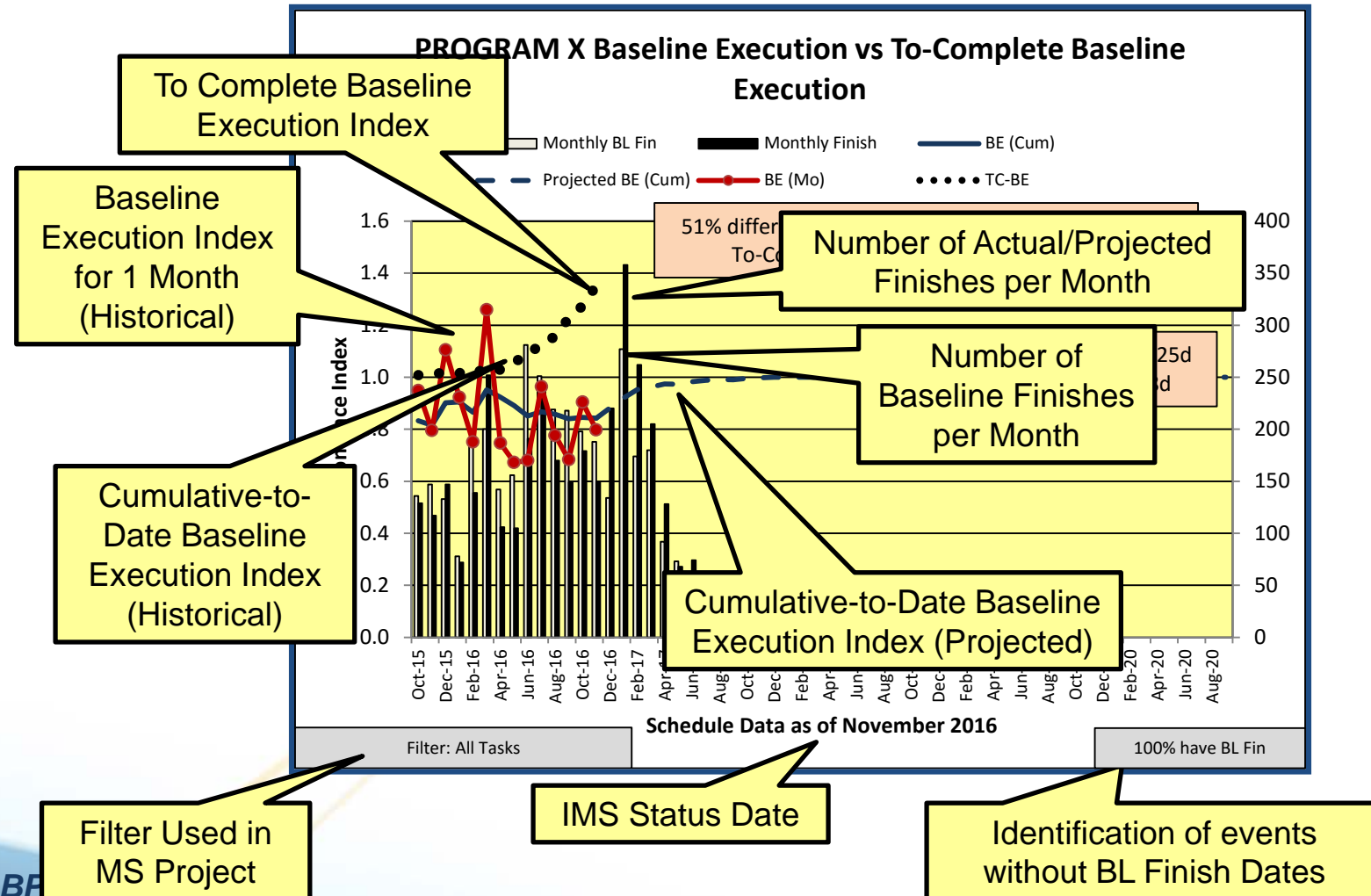


PROGRAM XYZ - ACT Baseline Execution



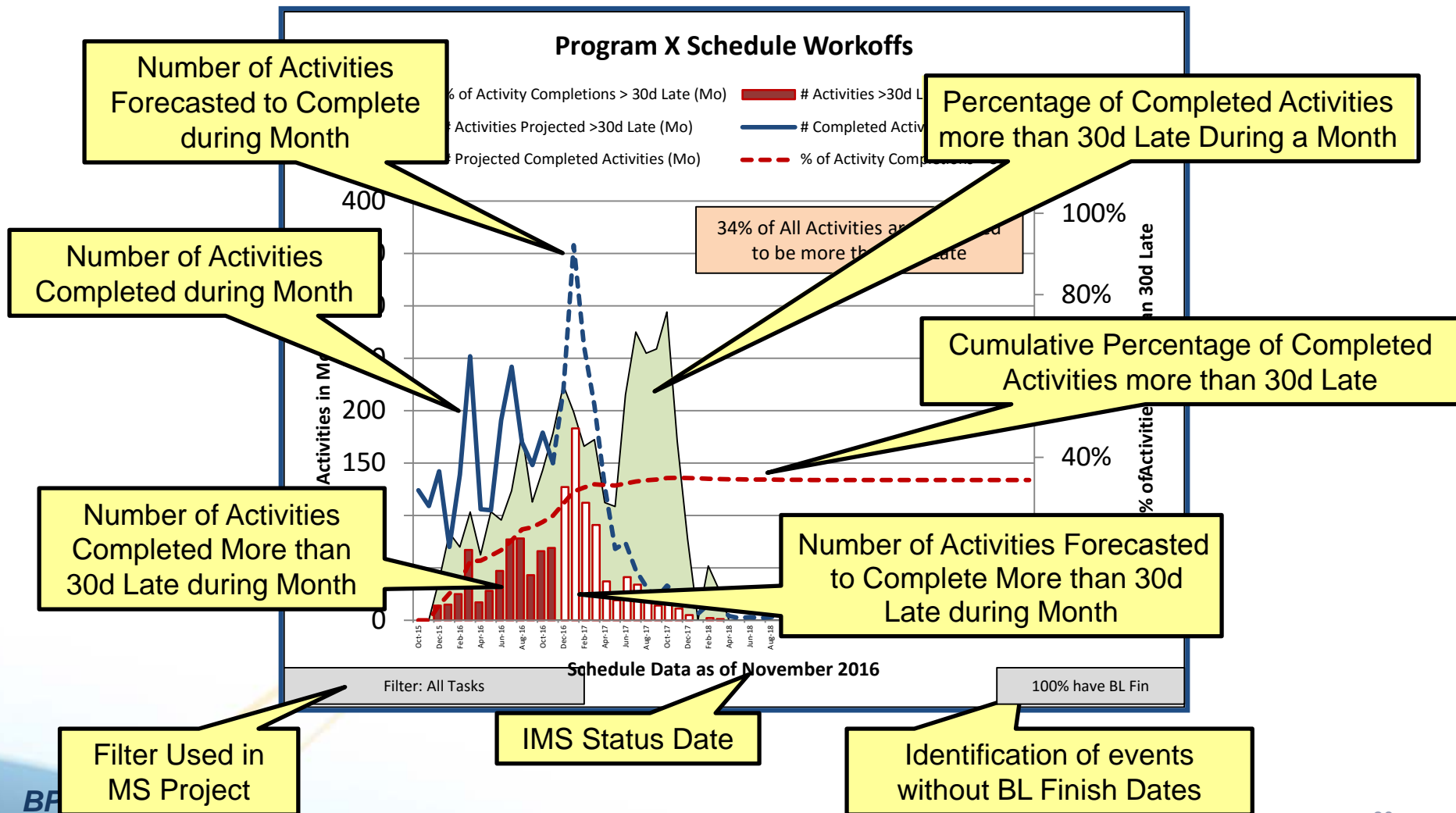


PROGRAM XYZ - ACT Baseline Execution vs To-Complete Baseline Execution



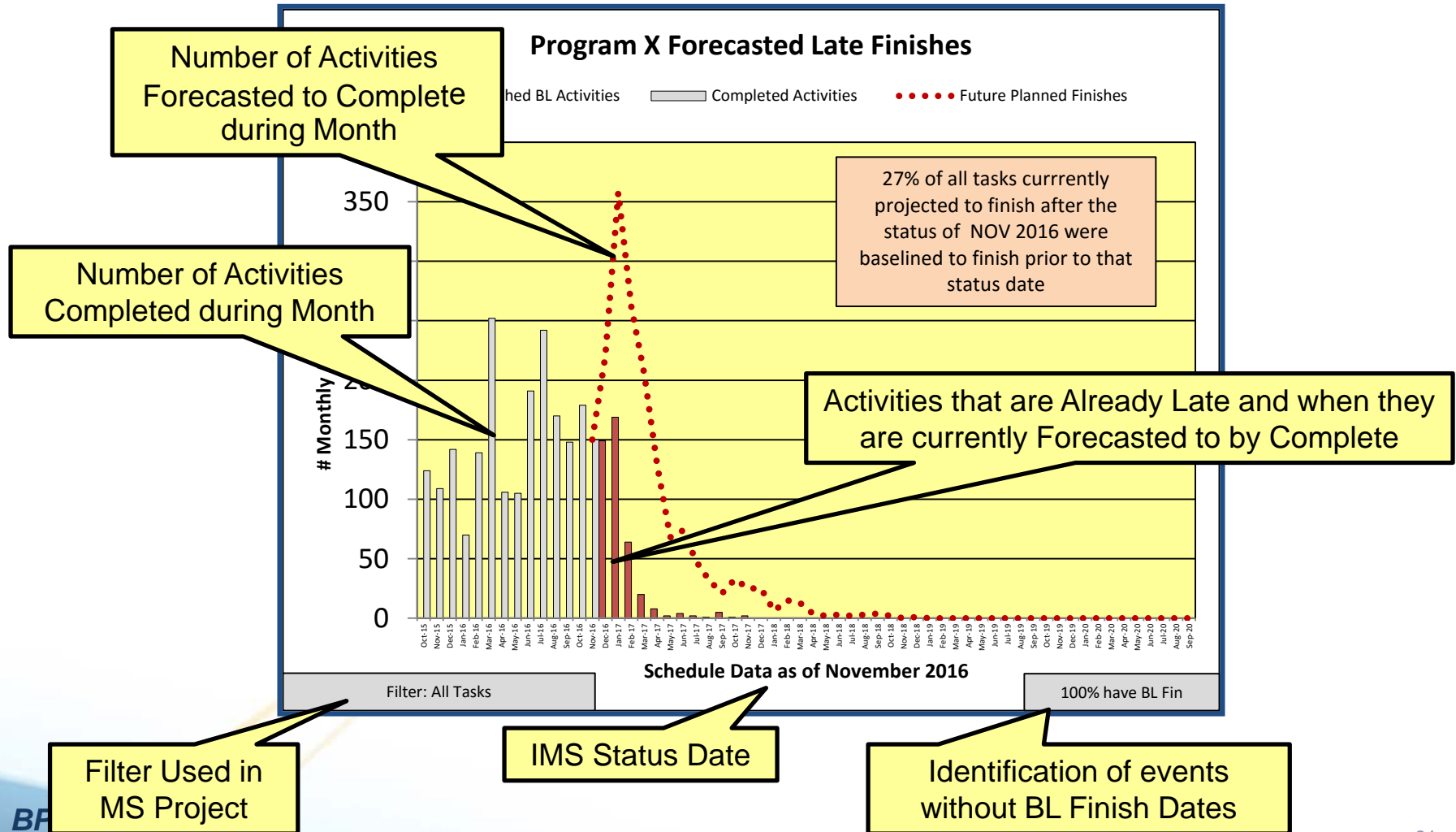


PROGRAM XYZ - ACT Schedule Workoffs



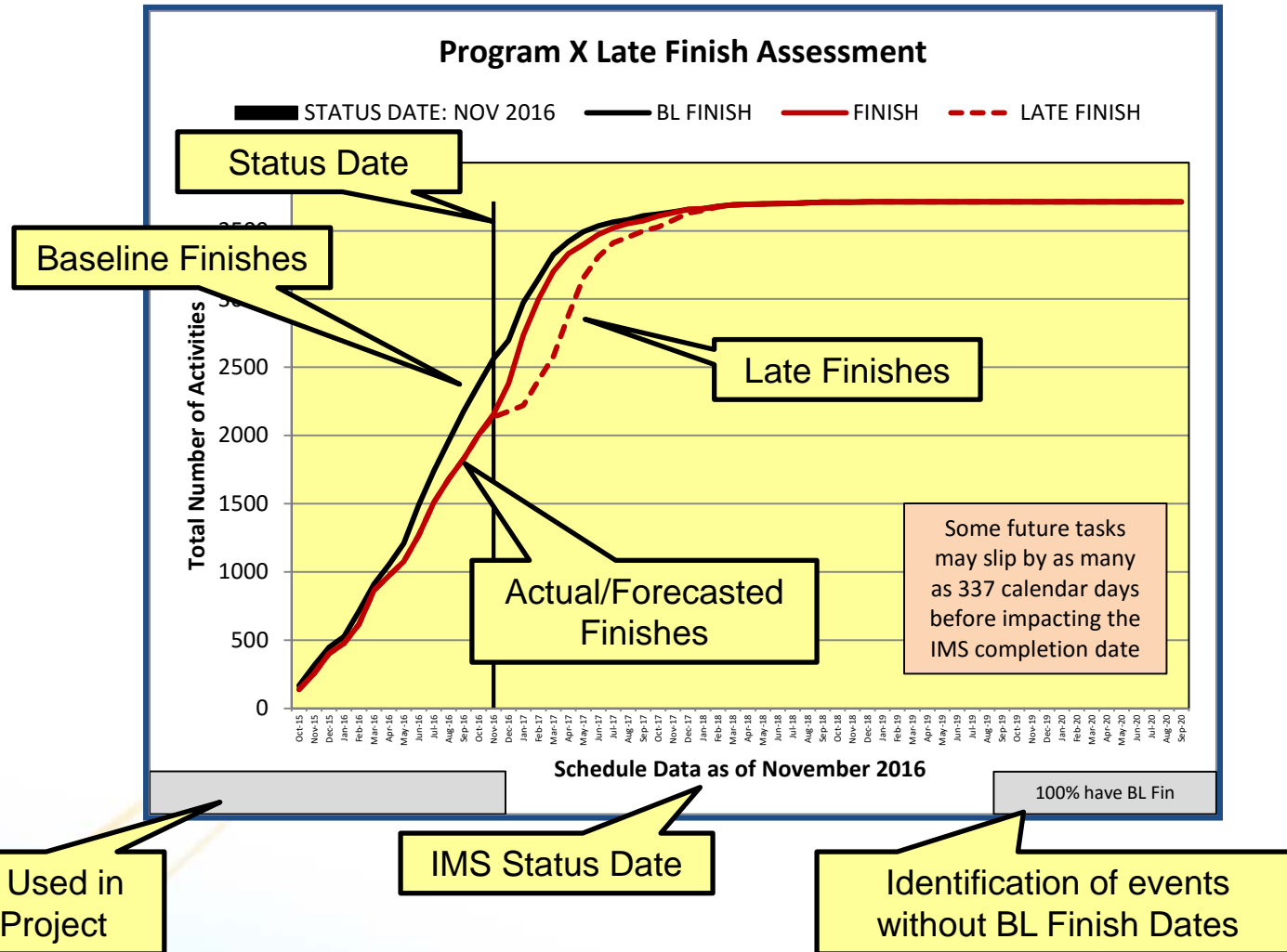


PROGRAM XYZ - ACT Forecasted Late Finishes





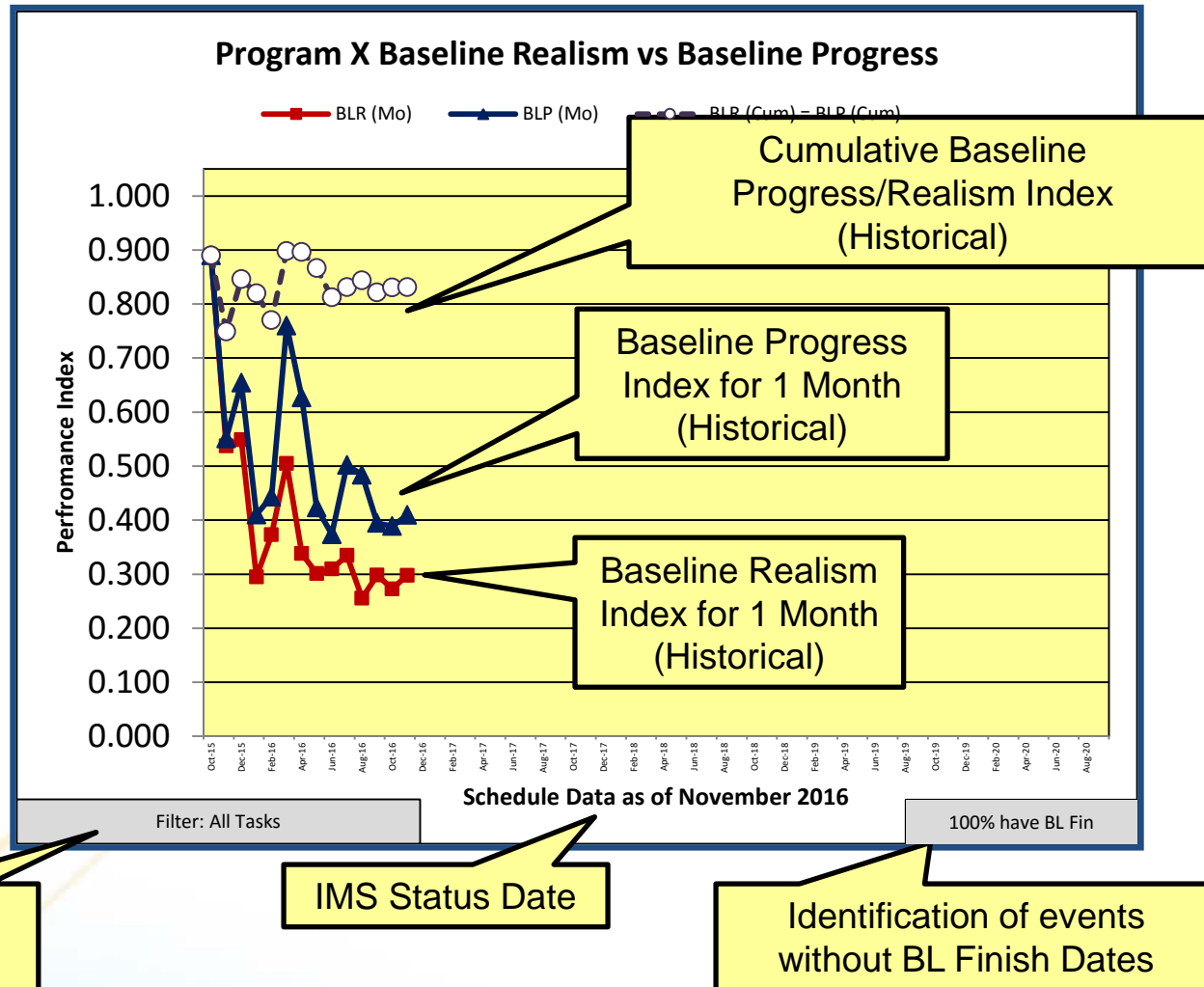
PROGRAM XYZ - ACT Late Finish Assessment



Notional Data

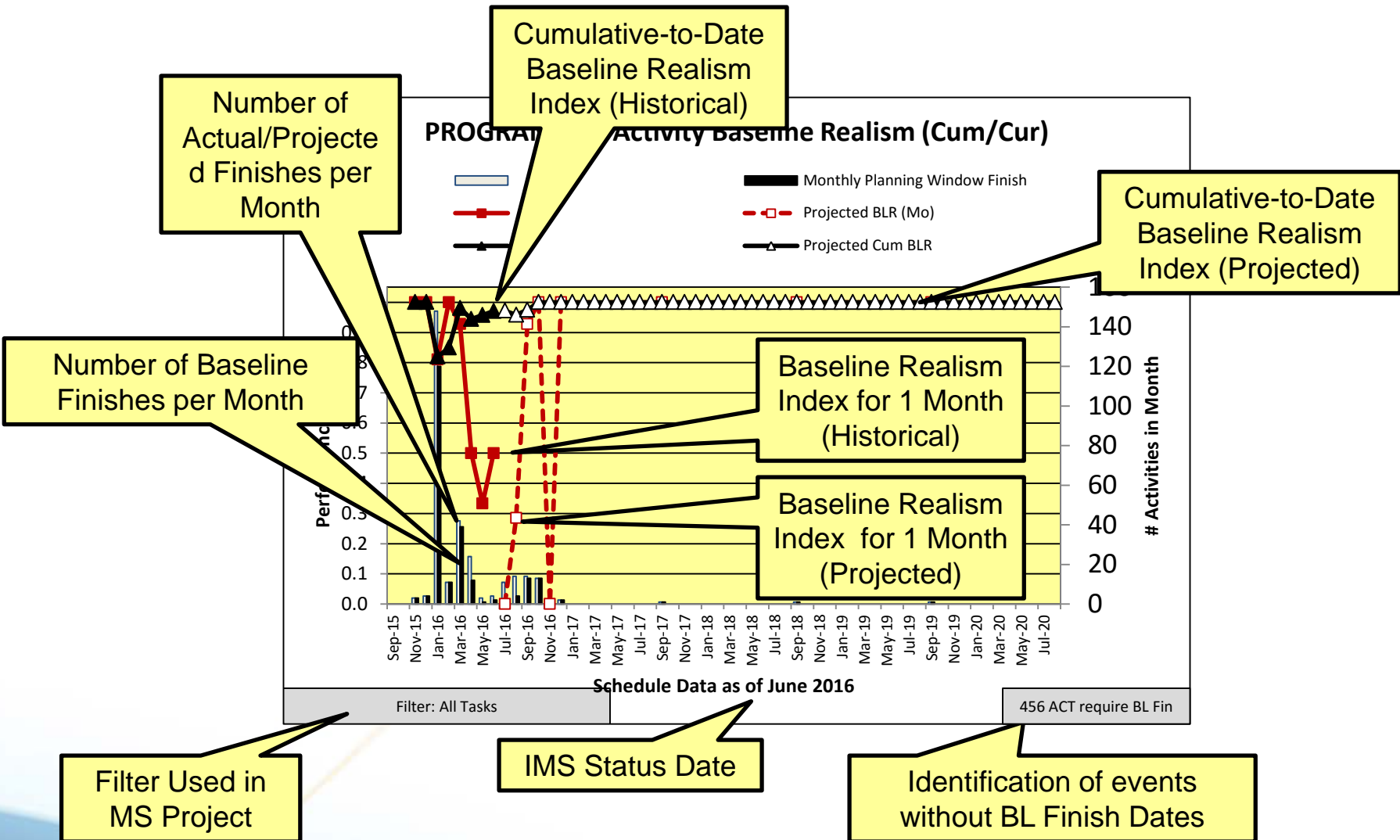


PROGRAM XYZ - ACT Baseline Realism vs Baseline Progress



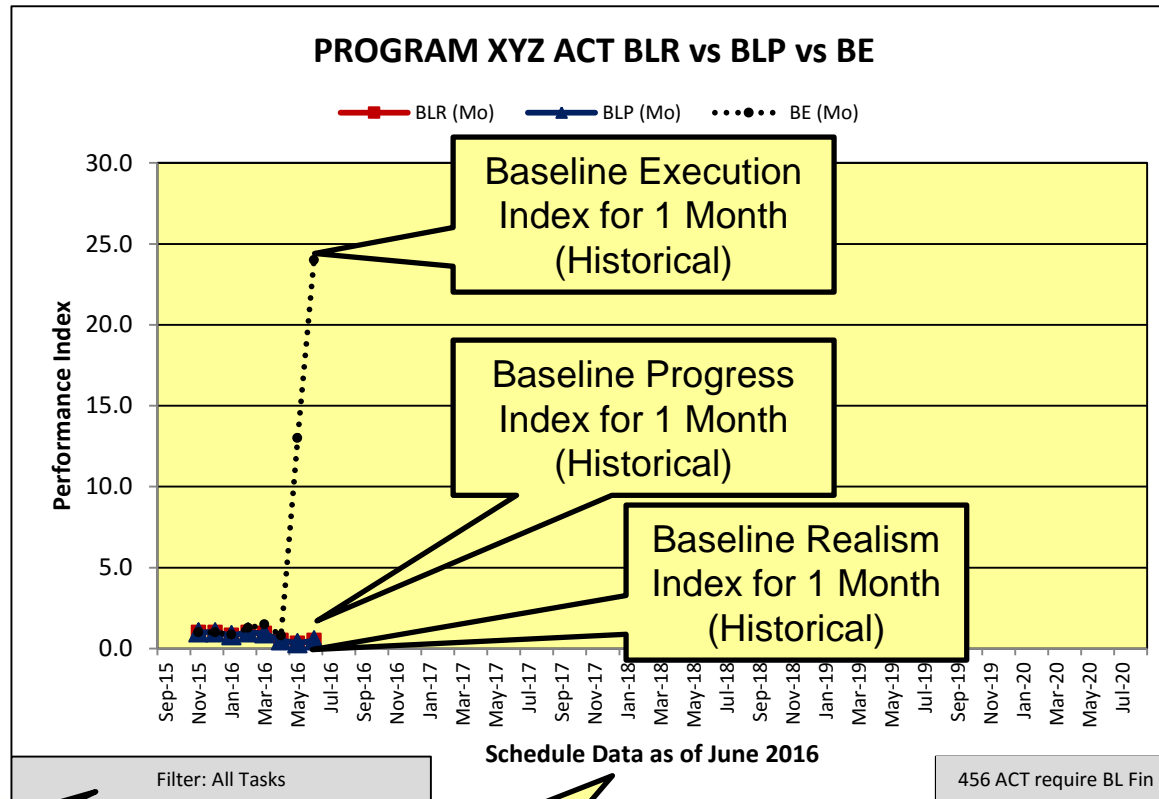


PROGRAM XYZ - ACT Baseline Realism (Cum/Cur)





PROGRAM XYZ - ACT BR vs BP vs BE



Filter Used in MS Project

IMS Status Date

Identification of events without BL Finish Dates



PROGRAM X - 1 Period ACT Forecast Realism

Forecast Realism is assessment of the actual completions to the projected completions (in this case ~125 of ~250 = ~.5)

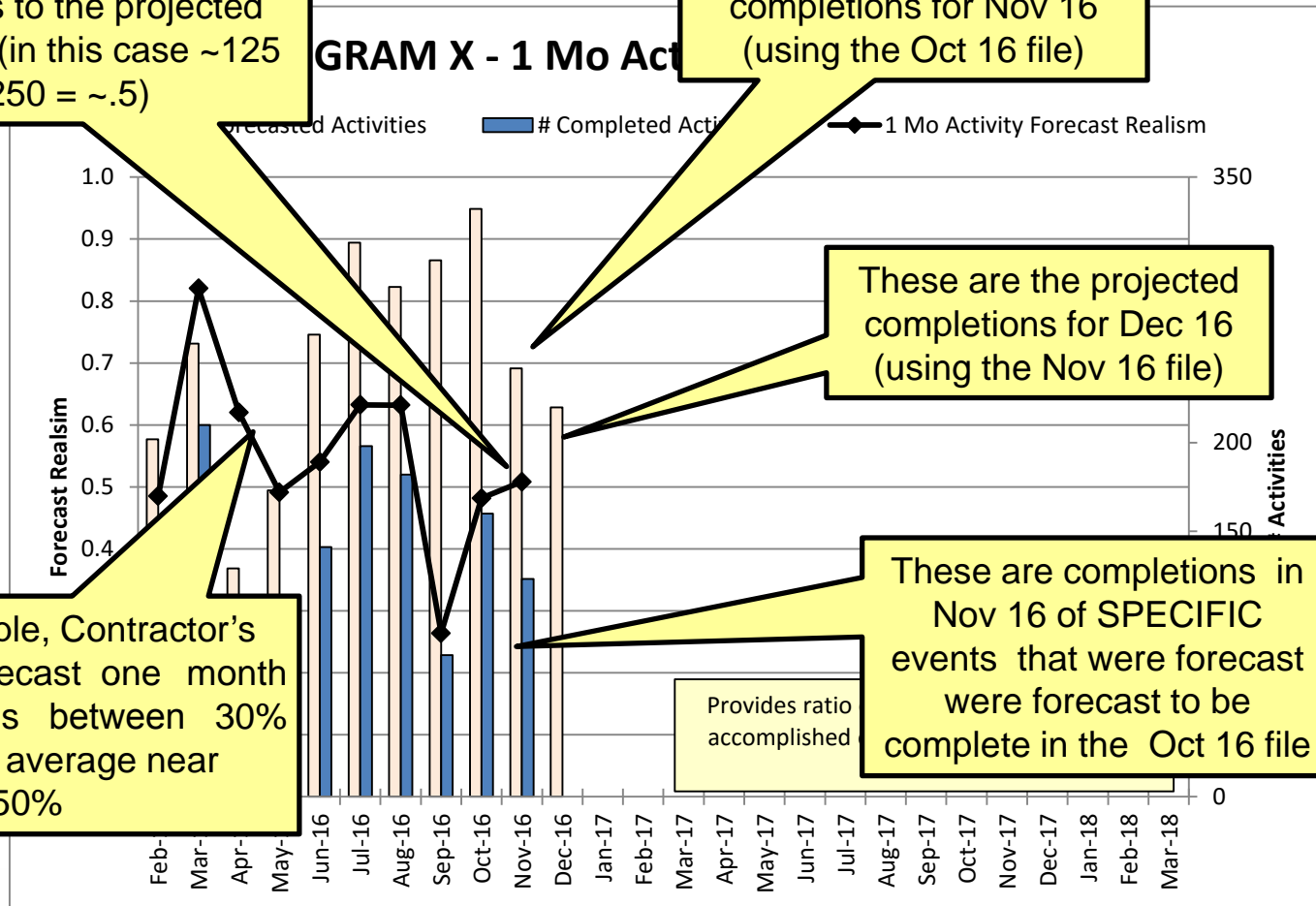
These are the projected completions for Nov 16 (using the Oct 16 file)

These are the projected completions for Dec 16 (using the Nov 16 file)

In this example, Contractor's ability to forecast one month ahead ranges between 30% and 80% with average near 50%

These are completions in Nov 16 of SPECIFIC events that were forecast were forecast to be complete in the Oct 16 file

Provides ratio accomplished



Note: This example uses Monthly Data and Status is EOM Nov 16

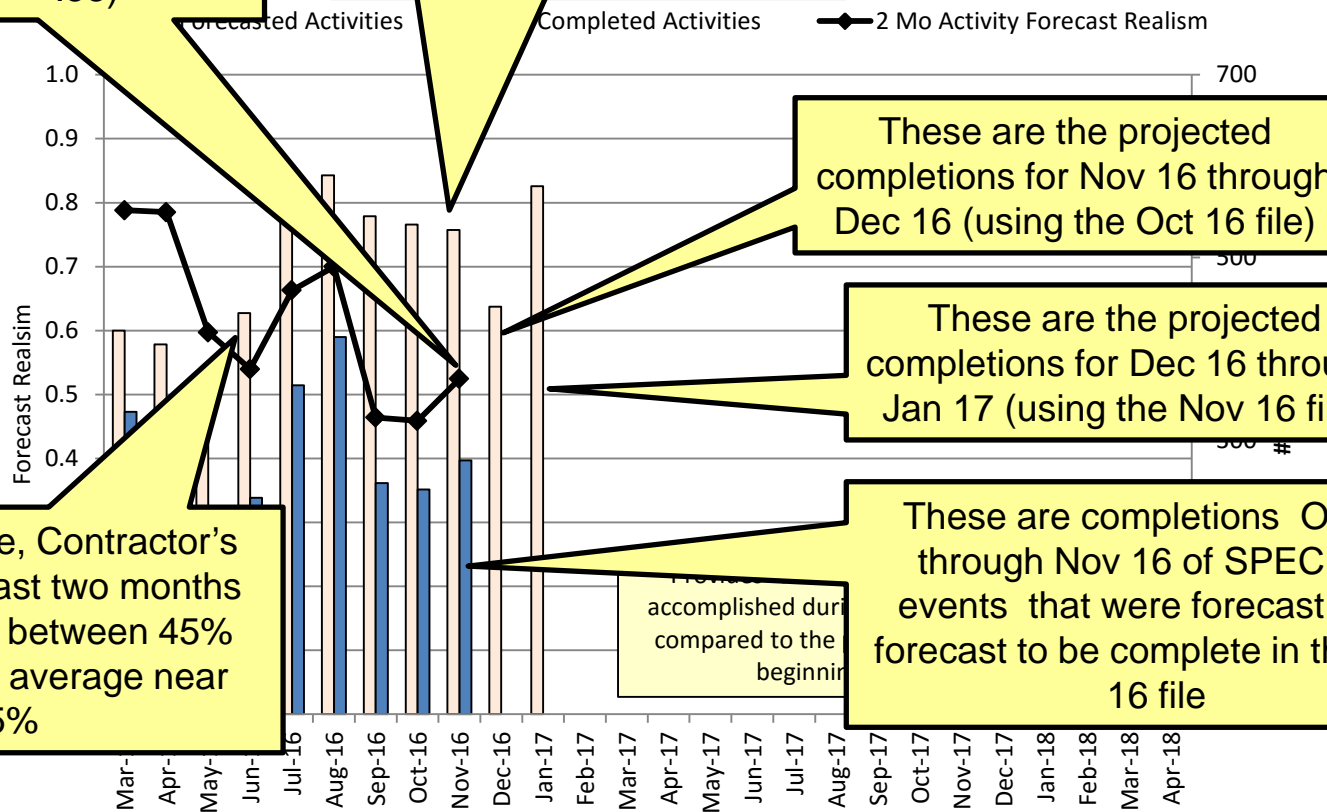


PROGRAM X - 2 Period ACT Forecast Realism

Forecast Realism is assessment of the actual completions to the projected completions (in this case ~275 of ~550 = ~.53)

These are the projected completions for 2 months of data - Oct 16 through Nov 16 (using the Sep 16 file)

Forecast Realism



In this example, Contractor's ability to forecast two months ahead ranges between 45% and 80% with average near 55%

Note: 2 Period is calculated based on Forecast Finishes during the next two periods

Notional Data



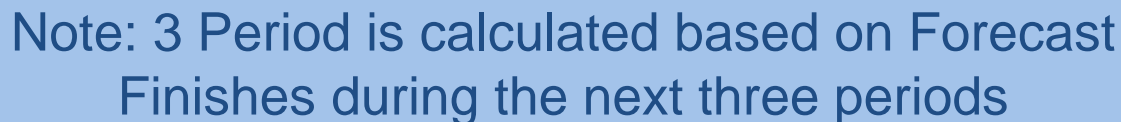
These are the projected completions for 3 months of data – Sep 16 through Nov 16 (using the Aug 16 file)

These are the projected completions for Nov 16 through Jan 17 (using the Sep 16 file)

These are the projected completions for Dec 16 through Feb 17 (using the Nov 16 file)

In this example, Contractor's ability to forecast three months ahead ranges between 50% and 80% with average near 60%

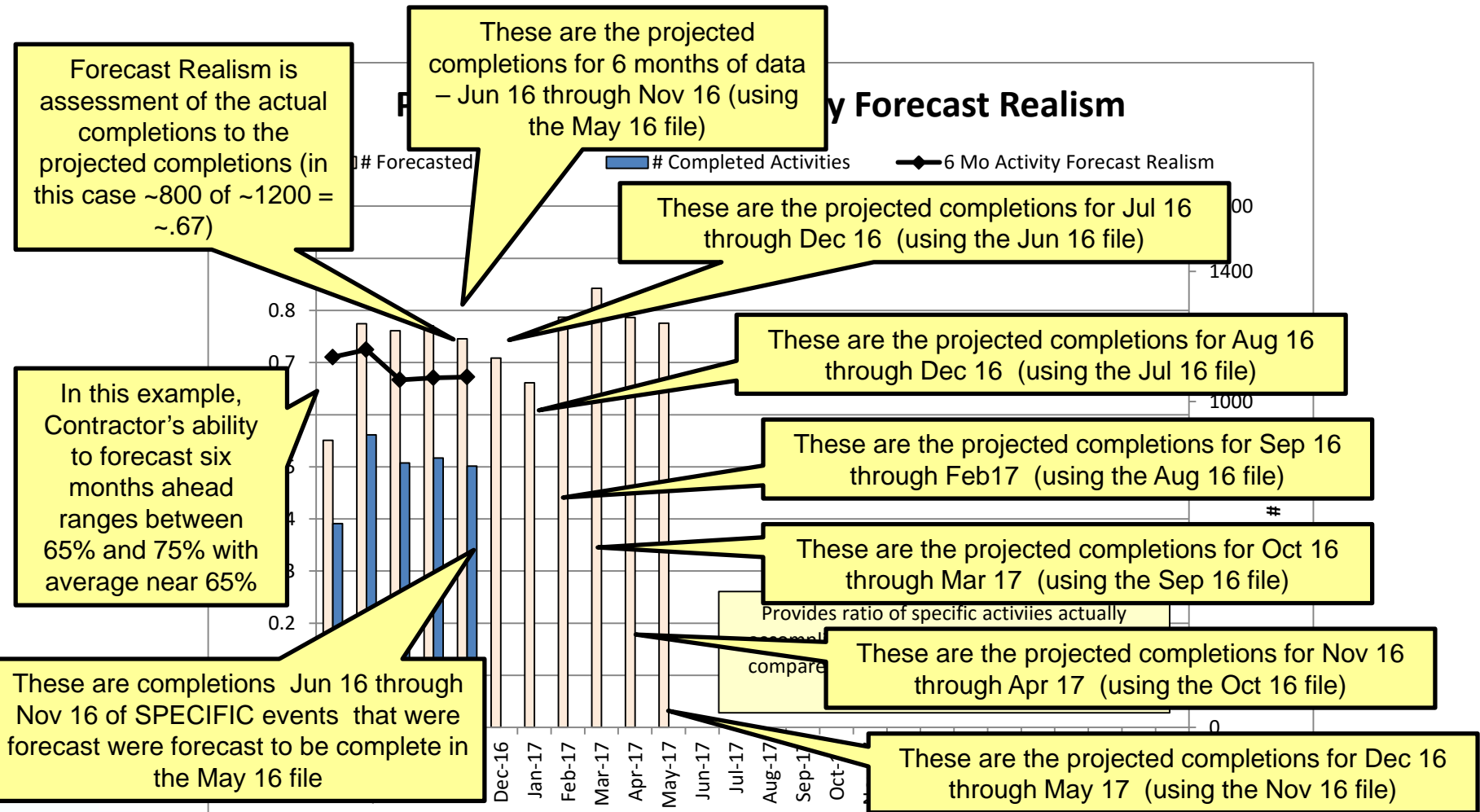
These are completions Sep 16 through Nov 16 of SPECIFIC events that were forecast were forecast to be complete in the Aug 16 file



Notional Data



PROGRAM X - 6 Period ACT Forecast Realism



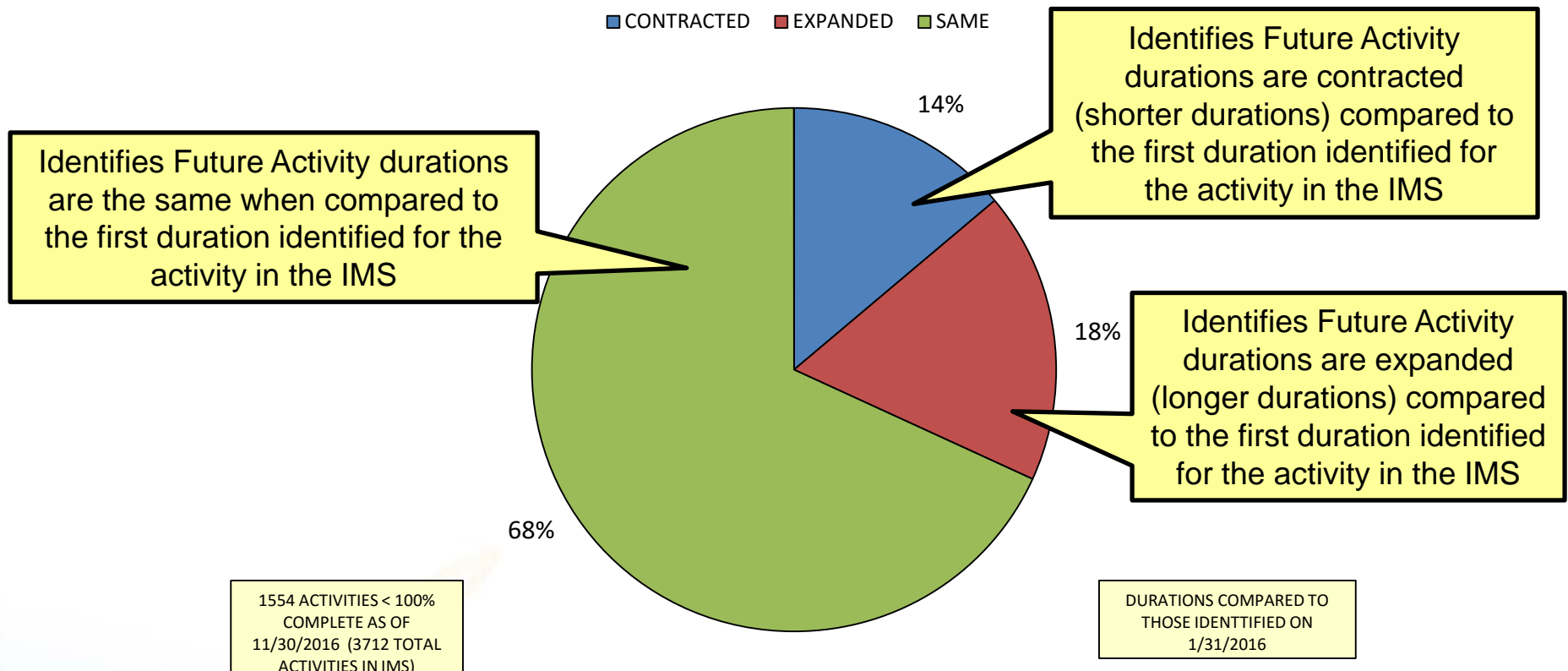
Note: 6 Period is calculated based on Forecast Finishes during the next six periods

Notional Data



PROGRAM X - Activity Future Durations

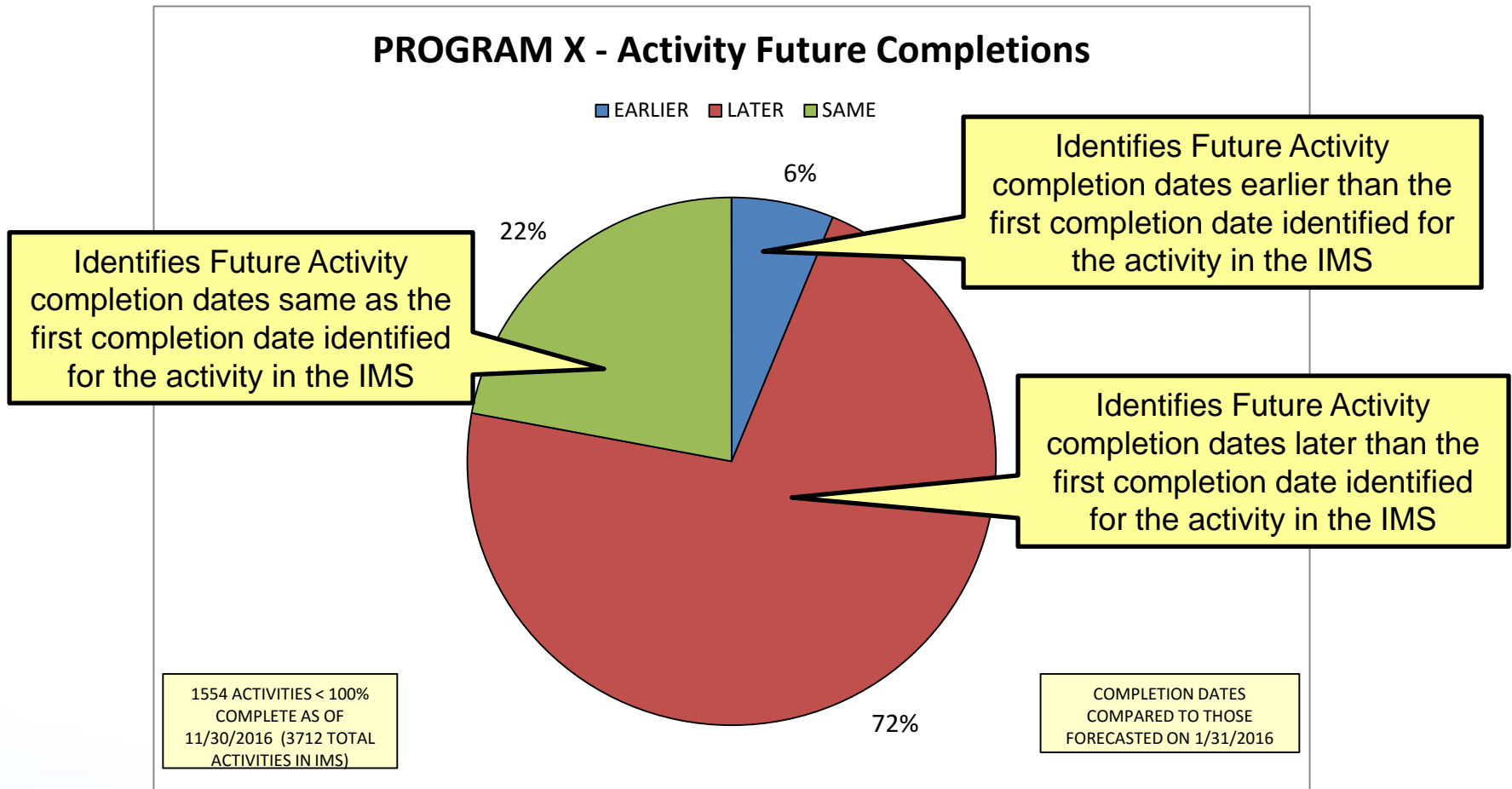
PROGRAM X - Activity Future Durations



Note: This chart is only available in FR_Activities



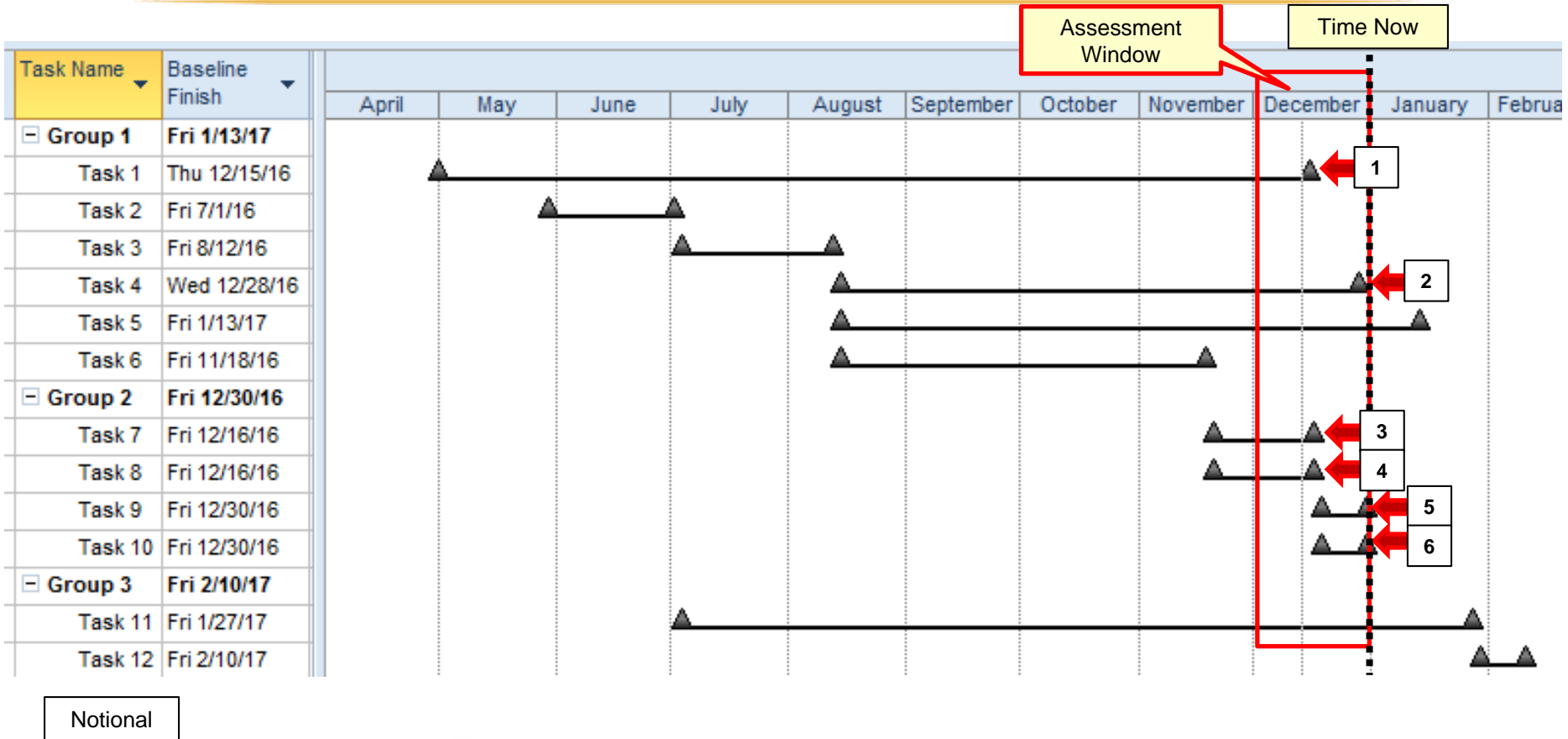
PROGRAM X - Future Completions (Activities)



Notional Data



Illustration - Baseline Plan



Number of activities planned for completion in the assessment window (6) is the denominator for calculating Monthly Baseline Realism, Baseline Progress, and Baseline Execution



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